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Among Our Writers

CHARLES P. BERKEY's advice has been widely sought on the geologic features of many large current bridge, tunnel, and dam projects. Among them have been the Madden Dam in the Canal Zone; the Bouquet Canyon Dam in California; the Kill Van Kull Bridge in New York; the Hudson River Tunnel at 39th Street, New York; various dam sites on the Snake River in Idaho; and the Norris, Joe Wheeler, and Pickwick Landing dam sites for the Tennessee Valley Authority.

F. E. WEYMOUTH was engaged in engineering work from 1902 until 1924 with the U. S. Bureau of Reclamation, being chief of construction between 1916 and 1920, and chief engineer from 1920 until 1924. After resigning from the Bureau in 1924, he was president of Brock and Weymouth, in Philadelphia, Pa., until 1926. From 1926 to 1929, he was chief engineer of the J. G. White Engineering Corporation, on irrigation projects for the Republic of Mexico. Since 1929 he has been engaged on the $200,000,000 Colorado River Aqueduct.

JULIAN HINDS was the recipient of the Society's Norman Medal in 1926. He entered the service of the U. S. Reclamation Bureau in 1910 as an assistant engineer on the Elephant Butte Dam. In 1927 he resigned as assistant to the designing engineer of the Bureau to become resident engineer for the J. G. White Engineering Corporation in Mexico. He began work on the studies for the Colorado River Aqueduct in 1928 and in 1930 was promoted to be assistant chief engineer in charge of all engineering and designing for the Metropolitan Water District of Southern California, which is now constructing the aqueduct.

J. L. BURKHOLDER is in active charge of all construction operations along the 250-mile length of the Colorado River Aqueduct. He was first retained by the Metropolitan Water District of Southern California in 1932 as division superintendent in charge of construction on 33 of the 92 miles of tunneling on the aqueduct. Later he was made assistant general manager of the District. For several years prior to 1932, he was chief engineer of the Middle Rio Grande Conservancy District in New Mexico. He was in the U. S. Reclamation Bureau for a number of years as a drainage engineer.

J. C. AGNEW is a graduate of Columbia University's School of Mines. He engaged in iron mining in the Lake Superior district successively as assistant to the president, in charge of raw materials, for the Midvale Steel and Ordnance Company; and as vice-president in charge of raw materials and ore sales, for the Rogers-Brown Iron Company. Since 1929 he has been a director of Winston Brothers Company, working on the Colorado River Aqueduct.

S. T. HARDING has been engaged on water-supply and water-requirement work in several of the Western states since 1907. For the past 20 years he has been Professor of Irrigation at the University of California. His consulting practice has included work for Federal, state, and private agencies in connection with water-supply studies and in determinations of title to the use of water.

CARLTON S. PROCTOR is a recognized expert on heavy and difficult foundation work. The firm of which he is a partner, Moran and Proctor, has advised on the substructure for the Philadelphia-Camden Bridge, the Ambassador Bridge, and the Mid-Hudson Bridge; on plans for the Svir Hydro-Electric Dam, Canal, and Lock in Russia and for the Palace of the Soviets; and on the Harkness Memorial Tower at Yale University, and the State Office Building at Albany, N.Y.

A. A. AGRAMONTE was graduated from New York University in 1903. After experience in New York City on sewers, water supply, and railroad work he entered the service of the Cuban Government. In 1910 he became resident engineer and later chief engineer of the Drainage Board of the Province of Buenos Aires, Argentina. Later he had charge, for the contractors, of construction work for the new port of Buenos Aires. Heavy foundation construction in South America engaged his attention until he undertook the work at the Port of Asunción, described in this issue.

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VOLUME 5

NUMBER 2

Foundation Conditions for Grand Coulee and Bonneville Projects

Two Current Columbia River Developments Discussed from the Geologist's Viewpoint

By CHARLES P. BERKEY

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
PROFESSOR OF GEOLOGY, COLUMBIA UNIVERSITY, NEW YORK, N.Y.

READERS are here privileged to learn from the pen of Dr. Berkey of the geologic conditions underlying two great Government dams in the Pacific Northwest. Although both are on the Columbia River, the situation at each site is unusual if not unique. Plans of the dams at the Grand Coulee and at Bonneville, published in the September 1934 issue of CIVIL ENGINEERING, *may be referred to for a better understanding of the character of the construction contemplated at these sites. Dr. Berkey's explanations of the formations encountered will be a help in appreciating the difficulties confronting the designers and builders. Both of these huge projects are now under contract. This article is part of a paper presented by Dr. Berkey before a meeting of the Metropolitan Section of the Society on January 10, 1934.*

ON the Columbia River there are two projects involving the building of large dams: one at Bonneville at the foot of the first series of rapids, 40 miles above Portland, in charge of the U. S. Engineer Corps of the War Department; and the other in the Columbia gorge at the head of the Grand Coulee in north central Washington, under the U. S. Bureau of Reclamation. The dam at Bonneville is intended primarily for the improvement of navigation and the development of hydroelectric power. The one at the Grand Coulee is to form the first step in a development to store and deliver waters for a large irrigation project in the Columbia basin and to furnish hydroelectric power. These two are so strikingly different in their geologic features and in the physical conditions which control their successful development that they must be described separately.

Grand Coulee is the more complex as a general project, although the conditions governing the construction of the great dam are somewhat simpler than those at Bonneville. The principal interest at Bonneville is the rare combination of geologic features, which introduces many problems not usually encountered in such variety at a single site. Both sites present questions as difficult to answer and problems fully as puzzling in connection with construction as those faced at Boulder Dam. It is probably not generally appreciated by the average engineer that these two projects have such a background of geologic complexity, or that the Bonneville Dam is to be built under geologic conditions much more exacting than any other under construction contemporaneously. And it is surely not appreciated by the average geologist that the Grand Coulee Dam is to be, when carried to full height, much larger than the great Boulder Dam on the Colorado.

SITE OF GRAND COULEE DAM, COLUMBIA RIVER

At Entrance to Grand Coulee, Where Three Major Geological Formations Are Shown: River Silt Exposed in Excavation in Foreground; Granites in Lower Walls of Valley and Bottom of Gorge; and Basalt Flows on Uplands in Background

HOW THE GRAND COULEE WAS FORMED

Grand Coulee is the name applied to a physical feature of no extreme rarity as a

type, but the most gigantic of its class. It is an abandoned trench made by the Columbia River, a veritable canyon extending for a distance of 40 miles or more across a section of the lava plateau of central Washington. It dates back to a time when the Columbia River was dammed by glacial ice pushing down from Canada across a bend in the course of the stream. Already a valley more than 1,000 ft deep had been excavated. The stream had cut entirely through a series of lava flows and 500 or 600 ft deeper into the granite floor beneath, before the ice dam was formed. When the oncoming glaciers finally blocked the whole river, it formed a lake which filled the valley above that point to the brim and then overflowed southward along the margin of the ice across the lava fields. Thus a new course was established for the Columbia, which it occupied long enough to make the gorge now known as the Grand Coulee and which is, in places, from two to three miles wide and more than 600 ft deep. In its course were rapids and falls. The principal fall, now dry, is more than three times the width and height of Niagara.

PART OF RESERVOIR SITE IN UPPER GRAND COULEE
Basalt Flows Form Sides of Gorge Over 500 Ft Deep, Bottom of Which Is Covered Largely with Silts

In the course of time, perhaps including several climatic fluctuations marked by alternating advances and withdrawals of the ice front, this blocade ultimately thawed away entirely, leaving the river to follow its old course. In the meantime, the old valley had been so long obstructed by the ice dam that it had become largely filled with silts and other transported debris left by the encroaching ice, settled out of the impounded waters. Also, great blocks of rock pried off from ledges on the valley sides were rafted to strikingly out-of-place positions, where the winds and currents of that time left them stranded and where they still remain. Thus some of the largest erratics known on the continent are genetically related to the glacial history of the Grand Coulee dam site. At first, therefore, the river found itself faced with the task of reexcavating its debris-filled valley. That process has gone on to the present day, and the river has not yet reached its former rock floor.

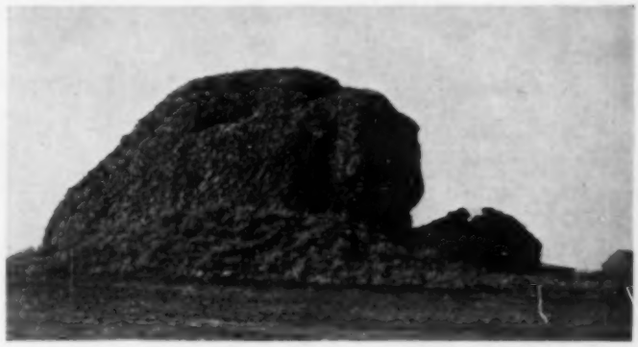
CONDITIONS AT THE SITE OF MAIN DAM

This old pre-glacial granite floor is still covered with silts and sands of river-lake origin and with gravels and mixed debris of fluvio-glacial type, as well as with occasional patches of glacial till. These deposits, which exhibit a surprisingly complex structural development, extend up on the sides of the gorge and form a cover that varies in thickness from 50 ft to more than 300 ft. As far as practical questions at the dam site itself are concerned, the situation is comparatively simple. There are only two major questions as regards the geology, although there are numerous minor problems which are much more obscure and difficult to solve. The two principal ones are:

1. What is the topography of the rock floor and what is its character and quality as bearing on the problem of safe and permanent support of a great dam?

2. What is the probable behavior of the overburden, especially as it relates to safe and economical excavation, so that the dam can be seated successfully on the rock floor?

Both these major elements, the rock floor and the overburden, present numerous minor problems that demand additional attention. However, it should be noted in the beginning, so as not to cause confusion in connection with subsequent detail, that the rock floor is granite and that it is eminently capable of carrying the dam. There are no insurmountable, or particularly obscure, or prospectively difficult, or suspiciously treacherous conditions represented by this formation. Therefore, from the geologic viewpoint, no serious doubt can be cast on the safety of the project.



A STRANDED ERRATIC, OR HAYSTACK ROCK IN THE GRAND COULEE
Many of These Blocks of Basalt Were Carried by Floating Glacial Ice from Their Parent Ledges and Stranded on the Uplands and Along the Valley Sides

Despite the evident tendency of part of the overburden, on account of its silty character, to slump and flow under the modified conditions, represented by excavation and redistribution of load, there is no apparent reason to regard this feature as of sufficient consequence to threaten the feasibility of the project. Of course it does present a real construction problem, and the method of handling it will be of interest to every construction engineer.

The earliest exploratory borings, put down through the overburden into the rock floor, indicated that the general profile is almost flat for a width of nearly 3,000 ft. Only two borings out of the original 16 deviated more than 20 ft from the average level, and these suggested that there might be holes in the floor. Much more detailed exploratory work has since substantiated these inferences reasonably well, and it is now known that the floor is not as smooth as the first trial profile assumed. There are undoubtedly many potholes and occasionally narrow notches or trenches following minor weaknesses in the floor where, because of crushing or close jointing, the rock is more susceptible to erosion than elsewhere. Pothole erosion, of course, is not at all rare or peculiar in river erosion on crystalline rock, and is to be expected under such conditions as are found at this site.

As the exploratory investigations proceeded, it was shown that there are occasional places where the rock is

more jointed and more altered than the average and that these places commonly correspond to the topographic depressions. Most of these features are regarded as matters of minor detail—not in any case of sufficient magnitude or importance to affect general conclusions with respect to the feasibility of the site or the general design and construction plans. It is such a floor as can be depended upon to support a great masonry structure of virtually whatever height other considerations may dictate. It is not peculiar to this site that there are minor residuary uncertainties, as for example the number and depth of pothole depressions, the number of narrow trenches that cross the site along the minor crush zones, or how much excavation may be advisable at places where superficial decay has affected the exposed rock. From the borings it is known that the granite continues to great depth

ROCK OUTCROPS IN VICINITY OF UPPER COULEE DAM SITE

and that it is a massive, competent, and stable formation, comparatively resistant to all forms of rapid destructive attack.

At this stage the overburden is a less vital concern. It is, of course, a matter of great practical importance to the builders of the dam, but after the excavation is completed and the dam established, it ceases to be of serious moment as far as the main structure is concerned. It is of importance chiefly during construction, except where conditions along the side of the valley are involved, and especially where secondary engineering structures are to be located on it as their main support. In that connection it is of importance at the retaining wall below the power house and along the highways, which cross reentrants and side gulches filled with deposits of this type; and at the town site, which is entirely located on river fill. Even the bridge which spans the river below the village must rest wholly on these very variable deposits. Some of them are gravels and sands. Their history is related to, and has a bearing on, the problem of finding suitable construction materials.

These are the major factors at the Grand Coulee Dam site. If it were not for the irrigation program, the story would be finished except for inspection and checking when the rock floor is finally uncovered and the foundations are exposed. By that time all these features will become matters of observation and experience rather than interpretation and prediction.

THE RESERVOIR IN THE GRAND COULEE

As regards the Grand Coulee or Columbia Basin project as a whole, however, this is not the whole story. When the project is completed it is to include a storage reservoir for irrigation purposes in the now dry canyon of the Grand Coulee. Here the problem takes an entirely different turn. It is proposed to place two low dams in this gorge: one near the entrance of the gorge, only a short distance from the great dam in the river valley below; and another 20 miles farther along, near the lower

SITE OF BONNEVILLE DAM, COLUMBIA RIVER

Bradford Island in Middle Foreground; Main Dam at Extreme Right; Power House and Locks Under Construction Within Cofferdams Across Channel to Left of Island

end of the first section of the gorge. Columbia River water will then be lifted 300 ft or more into the reservoir thus created, using the excess power, chiefly in seasons of high water. From this greater elevation, it will be possible to deliver the stored waters as needed through irrigation conduits to reclaim a large area of exceptionally fine semi-arid lands.

The chief problem in connection with this storage reservoir is whether it will hold water. Since all the water must be pumped, the efficiency of the tank is a matter of more concern than usual. Except at the two proposed dams, this reservoir is completely walled in by precipitous cliffs, at least 30 miles of which expose flat-lying lava flows and associated tuffs and ashes, while the rest of the circuit is granite—the same material as that into which the main river has cut its valley.

To put the situation briefly, the rock of the gorge bottom is almost everywhere covered with silts of such quality that it is believed to be sealed effectively against important leakage. Over large parts of the area these silts also overlap the sides of the gorge to sufficient height to add materially to the water-tightness of the enclosure. Nevertheless, there are comparatively long stretches, especially along the west side of the gorge near the south end, where only loose talus accumulations cover the edges of the trenched lava flows which form the canyon walls. This appears to be the only section requiring special consideration in judging the prospects of the reservoir and planning for its treatment and control. There are no critical problems attached to the dams in the Coulee. They will be earth dams in any case and can be placed where the local physical conditions are favorable in every important respect.

In reality therefore, the Grand Coulee project includes three dams instead of one, and consists of two reservoirs, one several hundred feet above the other, the lower one of which supplies both the water and the power for pumping into the upper one as a storage tank.

ANCIENT LANDSLIDE AT BONNEVILLE

Some four hundred miles downstream from the Grand Coulee, at the Bonneville site, the Columbia River is

much narrower than at any point above or below for many miles. At this place, which is immediately below the spot known as the Bridge of the Gods, there are rapids for a distance of two miles or more. It is plainly evident that the river takes an abnormal course against the side of the valley, as if crowded over by some encroaching mass. That is exactly the case. It appears that in an earlier time the river had eroded its gorge to a

ROCK FOUNDATION OF POWER HOUSE AT BONNEVILLE
Here an Intrusion of Basic Igneous Rock (Trap) Takes the Place of the Sedimentary Rock Which Underlies the Rest of the Site

depth somewhat greater than the present one. In this process certain sedimentary strata, made up largely of volcanic debris, which dip from the north gently toward the river, were undermined and became unstable enough to start landslides. Thus enormous masses of these deposits actually crept down from mountainous elevations and crowded into and across the valley, so that the river could not maintain its central course. Consequently it has been obliged to accommodate itself to a new position along the opposite, or south side of the valley.

There is not the slightest doubt as to the main features of this history, although the steps have been put much too simply in this description to agree in detail with the actual situation. The slumping movement did not take place all at once, and probably the river was able to maintain its course in the earlier stages better than in the later ones. Nevertheless, at one stage the valley must have been blocked more completely than it is now, for it is clear that the river is bravely attacking the landslide and has already removed part of the troublesome obstruction.

At the time of the greatest advance of the slide, a part of the mass which had moved forward the farthest was cut off in some prehistoric flood season, leaving a section of the slide on the opposite side of the river. This mass still remains and forms the core of Bradford Island, which lies between the two parts of the Bonneville Dam, the spillway section being on one side of it and the power house and lock on the other. In thus cutting across and through the landslide obstruction, the river has uncovered a pavement of residuary boulders, which overlies the rock floor and was left behind and covered over with slide material as the river was displaced. Therefore the present river bed at the Bonneville site is not in the deepest part of the original river channel, but is on a side slope of the valley, which is now being swept by the displaced river. The present main channel is flanked on each side by comparatively thick masses of landslide material, overlying deposits of boulders, gravel, and sand, which represent debris left there by the river as the oncoming mass of moving ground pushed it out of its course.

These are the controlling geologic conditions at the site of the main dam at Bonneville. The structure will rest on the sedimentary rock floor. The abutments will tie into landslide material on each side, which is underlain in part by pervious reworked deposits lying in turn on the bedrock floor. Fortunately the south end of the dam will reach heavy, tight ground lying directly on bedrock. For both abutments, special structures and treatment are planned in order to obstruct adequately the roundabout circulation of underground water. The major questions at this site as far as the dam is concerned are the following:

1. Is the character of the rock floor such as will provide adequate support and stability for the proposed structure?
2. In view of the character of the rock floor, are any special precautions in design and construction to be observed?
3. To what extent will the local formations be affected by the abnormal conditions imposed by the structure, such for example as the extra load, the increased head of water, and the spillway overflow, with its tendency to destructive erosion?

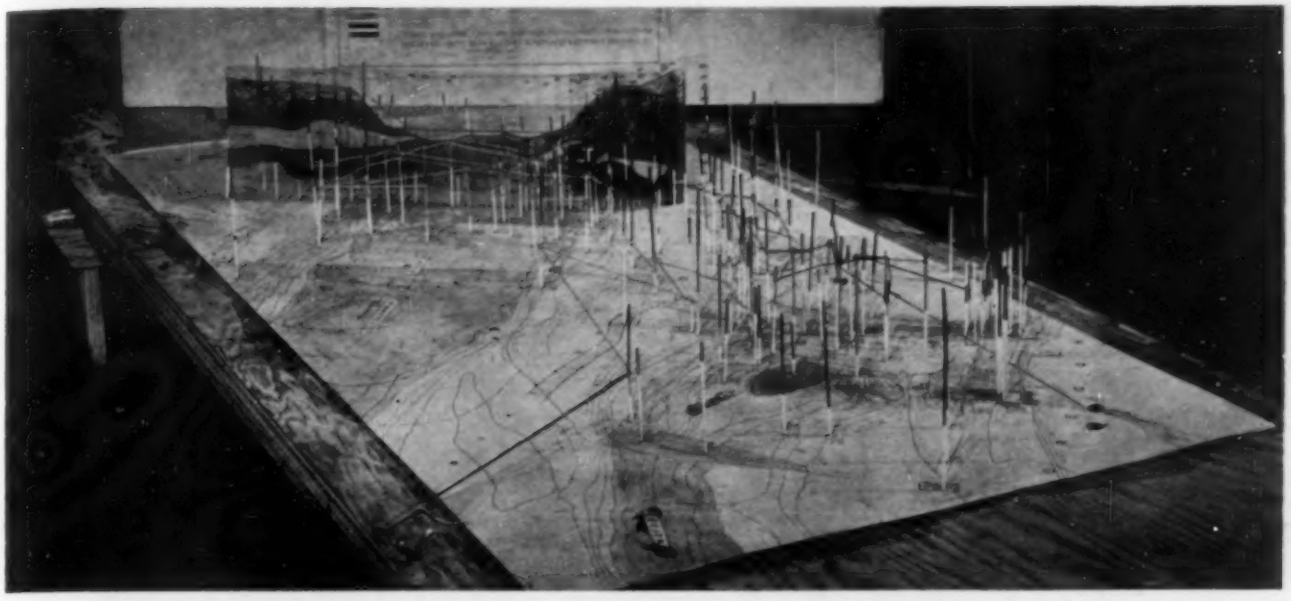
It is fully appreciated by everyone connected with the project that special provision in design and construction has to be made because of these unusual local conditions. The quality of the rock varies greatly from one bed to another. Parts of it could be easily eroded and might be deformed, if not effectively surrounded or protected.

EXCAVATING FOR THE BONNEVILLE LOCKS THROUGH TRAP ROCK

It is necessary, therefore, to seat the structure deeper than usual, to make its base much wider, and to so design it in connection with the overflow spillway that the erosional force of the water will be largely neutralized. It is fully appreciated also that the cut-off extending from the ends of the dam into the abutments must be carried to the rock floor and to such distance into the abutment ground as to meet the special local condition in each case.

All these matters have been provided for, and to the best of my belief the proposed steps are adequate from a geologic standpoint, although in saying this I do not undertake to speak for the design of the dam. The engineers have been careful to find out what the physical conditions are at the site, and are making the necessary modifications in design and construction plans to meet them. Exploratory investigations are still in progress under the immediate observation of C. P. Holdredge, associate geologist, and E. T. Hodge, consulting geologist, both of whom have given careful and continuous attention to securing required data, which are made available immediately.

This description completes the major physical picture at Bonneville as far as the main dam is concerned, but



MODEL OF EXPLORATORY BORINGS AT BONNEVILLE SITE TO AID STUDY OF GEOLOGICAL COMPLEXITIES
The Pegs Represent the Individual Borings and the Cross Section in the Background Shows the Subsurface Structure

that is only part of the program. There must be a great plant for power and an enormous lock for the handling of navigation. These are located on an irregular intrusive mass of trap, which originally outcropped in a high, rocky mass on the Oregon side of the channel behind Bradford Island. Later exploratory investigations proved that the same rock extends beneath that channel to Bradford Island in a large enough area to

SLUMP SCARPS AT THE FOOT OF RUCKEL SLIDE
About Two Miles Above Bonneville Site on Oregon Side

furnish a foundation for the power house. This is especially good fortune for there is no question whatever about the competence of this rock to carry these important structures.

One other question, however, remains—that of the character and quality of Bradford Island itself. Lying as it does between the power house and the dam, in reality it has to serve as a part of the effective dam. It must stand destructive attack and prevent excessive underflow of water both from the river above and from the side channel leading to the power house. It must carry a dike to raise the water to a moderate height above the present surface of the island, and it must provide the foundation for a cut-off and other structures, where needed, so as to make safe this stretch of ground between the power house and the main dam.

Now that a long series of exploratory borings have been made, there is good reason to believe that the internal structure of the island is fairly well understood. Investigations, however, are still being carried on to reveal all the conditions to be met and to determine more specifically the best location for the dike. It is not believed possible to stop completely the underflow through pervious parts of the overburden deposits, but the distance from one side of the island to the other is such that there appears to be no possibility of a sufficient movement of water through this ground to endanger any part of the proposed structure. Since detailed studies of conditions and proposed treatment are still in progress, plans for this structure are open to modification in keeping with whatever may be discovered in these investigations.

This is a bird's-eye picture of the geological features at Bonneville, one of the least homogeneous sites of any within my experience. It is complicated geologically and exacting from the engineering point of view. It will be an interesting and instructive experience to be able to check the conditions developed in the course of construction and the behavior encountered in operation with the interpretations made from exploratory data.

It would be a mistake to assume that these brief comments cover the whole problem. Questions not touched upon include relocation of the Oregon Short Line Railway and an attempt to discover some method of stopping ground that is still moving at the toe of Ruckel slide several miles farther upstream. These conditions apply only to ground on the Oregon side, far above the dam, and of course have nothing to do with the main dam and other structures at the Bonneville site.

It is a fair question whether the great landslide on the opposite side of the river at Bonneville, which brought about the very conditions that have made the dam possible, is still moving, and if not, whether it might begin again when new conditions are imposed by raising the water level. These questions cannot be argued here, but they have not been overlooked. It may be taken for granted that none of them is considered serious by those who have given most study to the situation. The complexity of the situation has been realized by the engineers and they have endeavored by complete investigation to remove every possible element of speculation or uncertainty affecting the construction of this project.

Colorado River Aqueduct Makes Rapid Progress

History, Design, and Construction of Huge Water Supply Project for Southern California

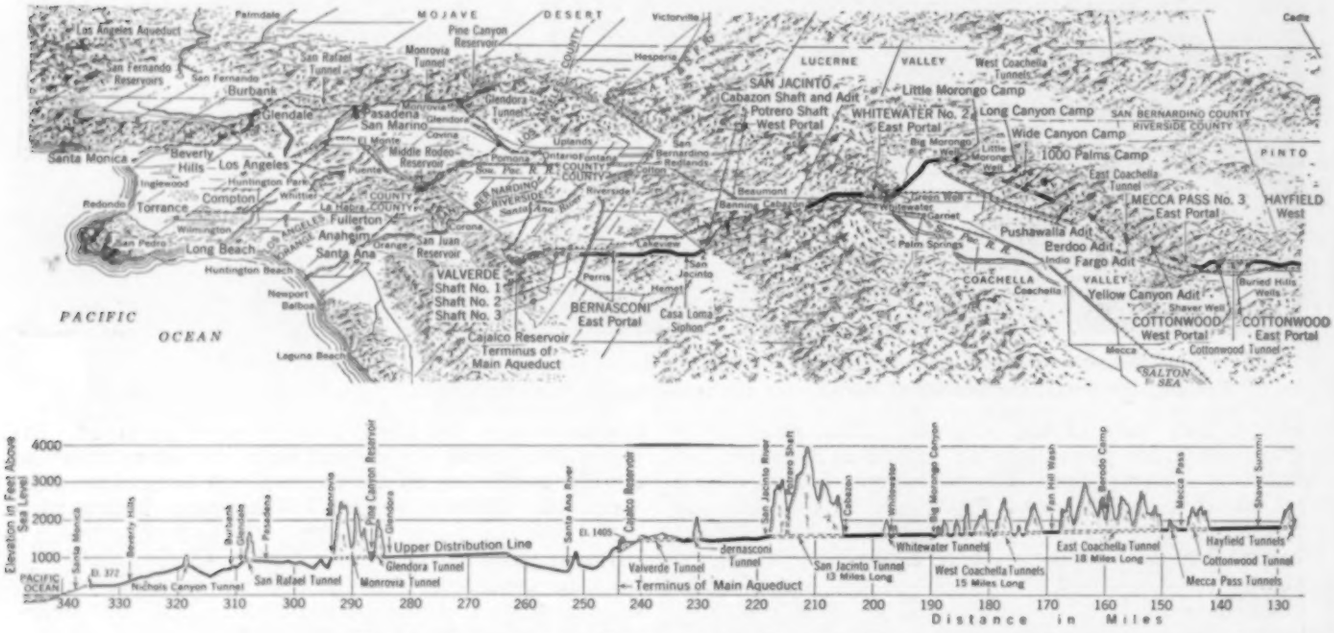


FIG. 1. ALIGNMENT AND PROFILE OF THE COLORADO RIVER AQUEDUCT, WITH LOCATION OF PRINCIPAL

UNPARALLELED progress is being made on the construction of the aqueduct which is to conduct 1,500 cu ft per sec from the Colorado River for 240 miles, across deserts and through mountains, to metropolitan Los Angeles. The forces of the Metropolitan Water District of Southern California and 13 separate contractors are digging the tunnels at the rate of 4 miles a month, and apparently all existing records have been broken for the rate of advance of a single heading. Already more than 60 per cent of the total of 91 miles of tunnel has been excavated. Although the main effort up to this time has been concentrated on the tunneling, contractors have recently attacked the construction of the diversion dam across the Colorado River at Parker, the cut-and-cover conduit, and the 150 inverted siphons. Also, the first work on the tunnels in the distribution system has been begun. Keen but friendly competition between the various construction forces has been responsible for the development and use of many labor- and time-saving devices. No effort has been spared by the District to make work on the aqueduct safe, healthful, and comfortable. The four articles which follow, dealing with the inception, location, design, and construction of this epochal project, were originally presented by the authors in the form of addresses before the Los Angeles Section of the Society on the evening of December 12, 1934.

Organization, Location, and Financing

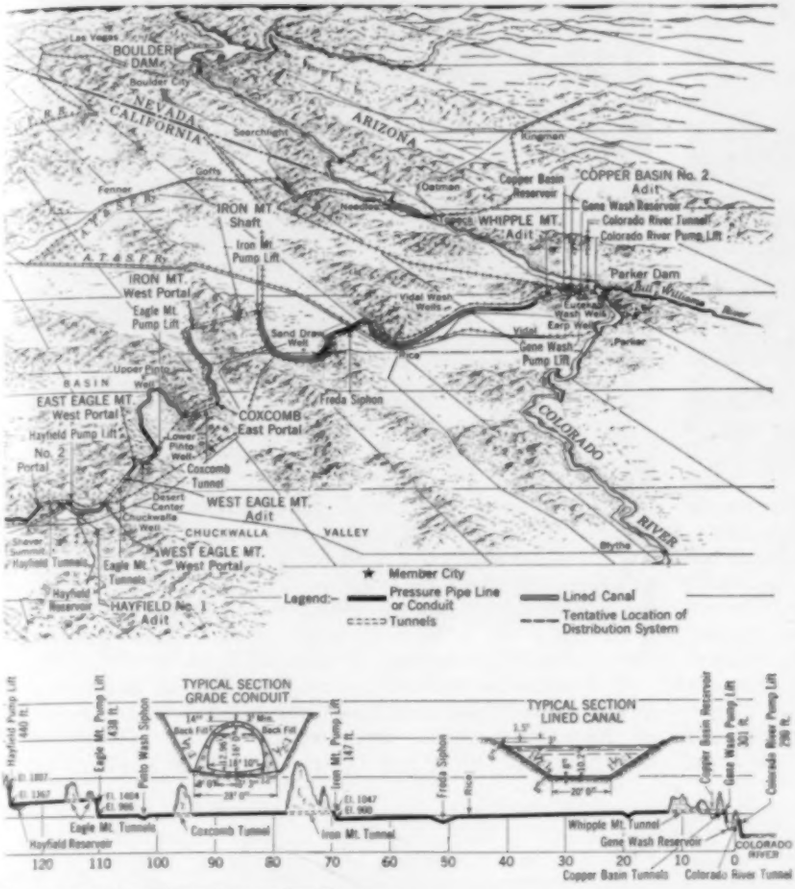
By F. E. WEYMOUTH

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

GENERAL MANAGER AND CHIEF ENGINEER, THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA, LOS ANGELES, CALIF.

LOCAL water resources available to Los Angeles and the neighboring communities have been undergoing a gradual but certain depletion over a period of many years, and the water now being extracted from the vast underground reservoirs considerably exceeds the natural replenishment. That such a situation was imminent was realized many years ago and this realization led to the construction by the City of Los Angeles of the Owens River Aqueduct, the importance of which to the community cannot be overestimated. More than ten years ago it became evident that the waters made available by this aqueduct were inadequate to supply the ultimate needs of even the City of Los Angeles and that, because of similar needs in the surrounding region, it was imperative that some new outside source of water supply be found.

At that time William Mulholland, M. Am. Soc. C.E., then chief engineer of the Department of Water and Power of the City of Los Angeles, began an intensive search for a new supply. The only adequate new source



TYPICAL SECTION GRADE CONDUIT
TYPICAL SECTION LINED CANAL
Hayfield Pump Lift 440 ft.
Eagle Mt. Pump Lift 438 ft.
Pinto Wash Siphon
Iron Mt. Pump Lift 147 ft.
Freda Siphon
Rice
Copper Basin Reservoir
Gene Wash Pump Lift 301 ft.
Colorado River Pump Lift 290 ft.
Eagle Mt. Tunnels
Coxcomb Tunnel
Iron Mt. Tunnel
Whipple Mt. Tunnel
Gene Wash Reservoir
COLORADO RIVER
Copper Basin Tunnels
Colorado River Tunnel
120 110 100 90 80 70 60 50 40 30 20 10 0

STRUCTURES AND DISTRICT TO BE SERVED

was found to be the Colorado River, the low flow of which was fully appropriated for use in the Imperial Valley, southeastern Arizona, and Mexico. However, the flood waters wasting into the sea each year were found to be sufficient to supply all the needs of southern California. These flood waters could be conserved by a storage dam at Boulder Canyon. This dam is now under construction by the U. S. Bureau of Reclamation, and is nearing completion.

SELECTION OF THE AQUEDUCT ROUTE

Studies of the problem of constructing an aqueduct leading from the Colorado River were begun by the Water Bureau of the City of Los Angeles in 1923, prior to the final acquisition of water rights on the river and long before the creation of the Metropolitan Water District of Southern California. As the investigation proceeded, other cities became interested in the project, with the result that the District was organized in 1928, and formally took over the planning of the project with its own staff on May 1, 1930.

Much of the desert area between the District and the river was found by the first investigators to be unsurveyed and unknown. The topography was not such as to point definitely to a single, best aqueduct location. Accordingly, a general topographic survey was begun and maps were assembled from which the problem could be studied. A total area of nearly 25,000 sq miles was surveyed. Many maps from miscellaneous sources were assembled and brought to a uniform scale to produce a general topographic map for all the southern part of California and parts of Nevada and Arizona.

When maps became available, a large number of office locations and preliminary estimates were made, and many possible routes were suggested by interested individuals. All such suggestions were given consideration in order that no worthy plan should be overlooked. One proposal contemplated a diversion at Glen Canyon, Utah, with an aqueduct more than 800 miles long, serving not only southern California, but also large areas of Utah and Nevada. At the other extreme was a proposal to divert from the Laguna Salada in Mexico through an aqueduct up the coast by way of San Diego. Many intermediate diversion points were proposed. Usually there were many possible aqueduct routes from each diversion point. As a result, literally hundreds of alternative routes were studied.

The requirement that tunnel construction be reduced to a minimum caused the projected routes from the various diversion points to converge toward a few mountain passes, such as the Cajon Pass north of San Bernardino and the San Gorgonio Pass at Beaumont. However, since passes often result from a structural weakness, which may seriously interfere with tunneling, they must be considered with care. Earthquake faults, crushed rock zones, and water-bearing alluviums are other geological hazards that must be avoided as far as possible. Geological factors were in all cases given careful consideration. Facility of diversion, freedom from cross-drainage difficulties, accessibility to existing transportation lines, safety, permanance, and cost of construction, right of way, and operation were important elements in determining the final location.

ROAD CONSTRUCTION OF METROPOLITAN WATER DISTRICT
Part of the 148 Miles of New Road Built to Give Access to the Work

SITE OF THE PARKER DAM

SAN JACINTO MOUNTAIN AND DISTRICT TRANSMISSION LINE
The Longest Single Tunnel on the Aqueduct Pierces This Range

BERDOO CAMP, HEADQUARTERS OF THE COACHELLA DIVISION
Air-Cooled, Electric Lighted, Refrigerated, and Hospitalized

Of basic importance was the fact that the Colorado River is separated from the District area by a major divide. Also, the river is generally at a lower elevation than much of the area to be served, and hence an appreciable head is required to overcome friction in the conduits leading to the District. Gravity flow is possible only for diversions from high dams far up the river and these would require long tunnels under mountains and desert plains. Several such routes were investigated and abandoned as impracticable.

Careful study of all possible routes led to the final selection of a diversion site 18 miles up the river from Parker, Ariz. This decision was influenced by a combination of economic, topographic, and geologic factors. Among the advantages of the chosen route are the facts that it is considered the safest to build and to maintain; it requires less gross pump lift than any other feasible location; and at the point of diversion the river is confined in a narrow rock canyon. The general location of the route may be seen in Fig. 1.

The main line of the aqueduct from Parker terminates in the proposed Cajalco Reservoir, about 12 miles south of Riverside, Calif., from which point distributing lines to the cities of the District are to be built. The

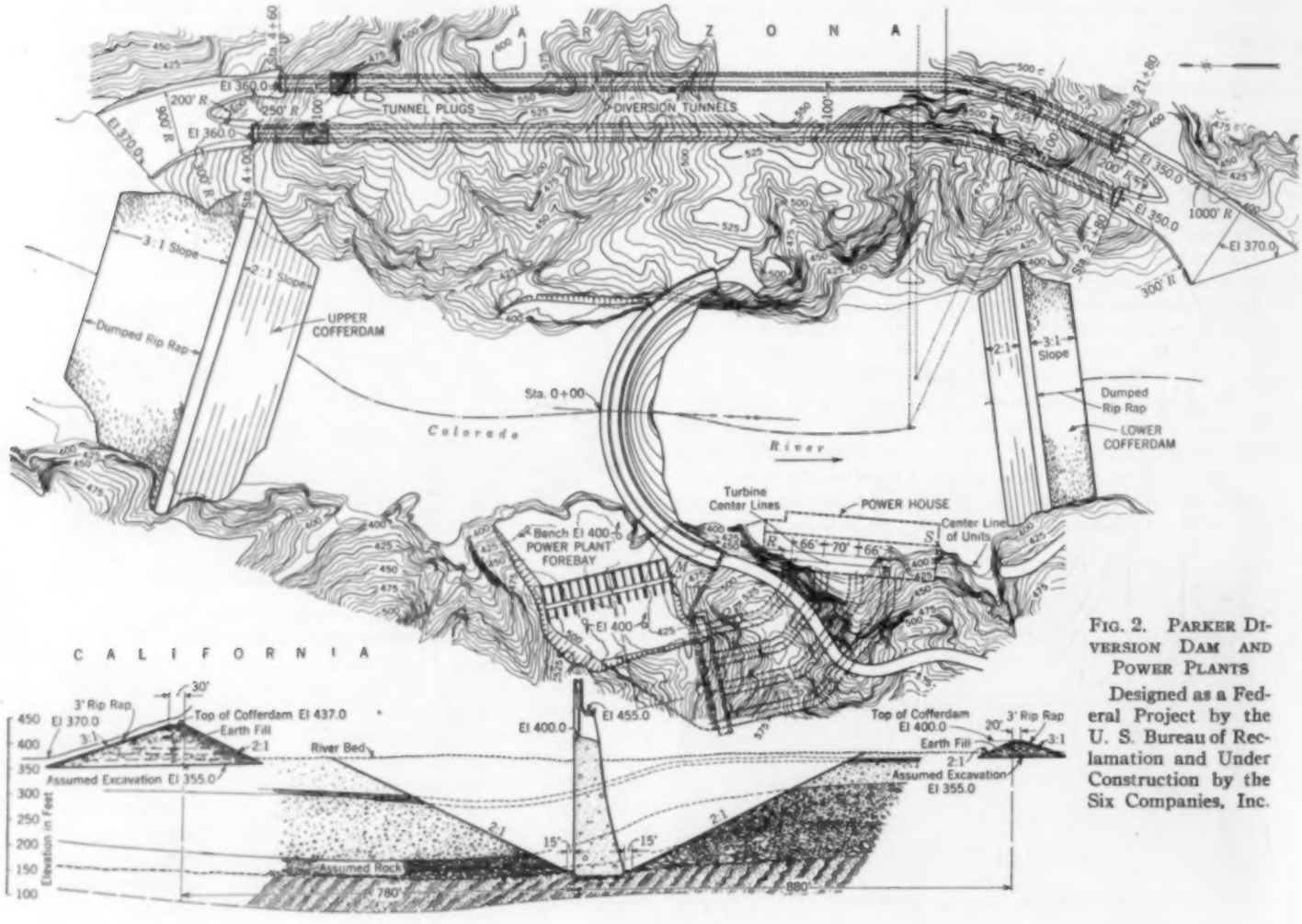


FIG. 2. PARKER DIVERSION DAM AND POWER PLANTS
Designed as a Federal Project by the U. S. Bureau of Reclamation and Under Construction by the Six Companies, Inc.

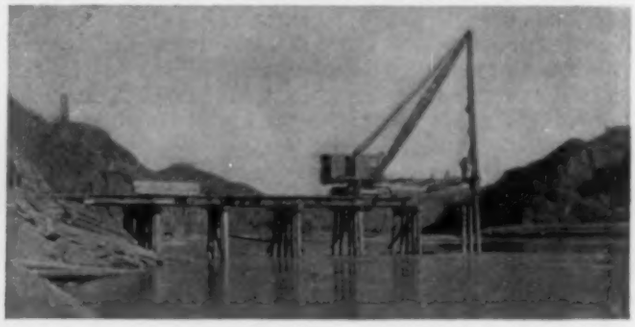
section from the river to the Cajalco Reservoir is composed of 91.94 miles of tunnel, 54.65 miles of cut-and-cover conduit, 62.47 miles of open lined canal, 28.86 miles of pressure pipe, 1.19 miles of pump discharge line, 2.29 miles of passage through reservoirs, and 0.91 mile of outlet cut from the last tunnel, making a total length of 242.31 miles. From the Cajalco Reservoir the flow is to be conveyed to the member cities in pressure lines, conduits, and tunnels. Retail deliveries will be made,

SIX COMPANIES' CONSTRUCTION CAMP FOR PARKER DAM

not by the District but by the water departments of the various cities.

CAPACITY OF THE AQUEDUCT AND PUMPING PLANTS

The aqueduct is designed for a flow of 1,605 cu ft per sec, or approximately 1,000 mgd. With a 7 per cent allowance for shutdowns, this gives an average flow of 1,500 cu ft per sec. This full flow will not be needed in the first years of operation, but it is uneconomical to construct the tunnels, canals, and conduits of the main aqueduct for smaller capacity and then enlarge or duplicate them in later years. However, the pumping plants and pipe lines may be economically built in parallel units and therefore parts of these facilities not needed during the first years of operation are to be left for future construction. The work scheduled for initial construction will provide a complete system capable of delivering water to each city of the District, providing a reserve capacity sufficient for several years, and capable of being quickly expanded to meet a growing need for water.



BUILDING TRESTLE OVER COLORADO RIVER FOR PARKER DAM

On the adopted route there are to be five pumping plants in all, having a total lift of 1,618 ft. There will be two at the river and three others just east of Shaver's Summit. Each plant will ultimately contain 9 units of about 200 cu ft per sec capacity each, which will allow one spare unit in each plant. These units will not all be installed at the beginning of operations but will be added from time to time as the demand for water requires. Plans for the plants are in preparation. An extensive research program for the solution of pumping and water-hammer problems is being carried out by the District staff at the California Institute of Technology in Pasadena.

Power for operating the pumps is to be obtained from the Government's hydro-electric plant at Boulder Dam, under the provisions of a contract with the Secretary of the Interior, dated April 26, 1930. Under this contract, the District is allocated 36 per cent of the firm power and preferred right to all secondary power produced at the dam. Firm power is to be paid for at 1.63 mills per kwhr and secondary power at 0.5 mill per kwhr, the District to pay separately for the installation and operation of the generating machinery. The District will build and operate its own transmission lines along the approximate locations shown in Fig. 1, and will have the right to develop power at Parker Dam and at such drops as may occur in the distributing system.

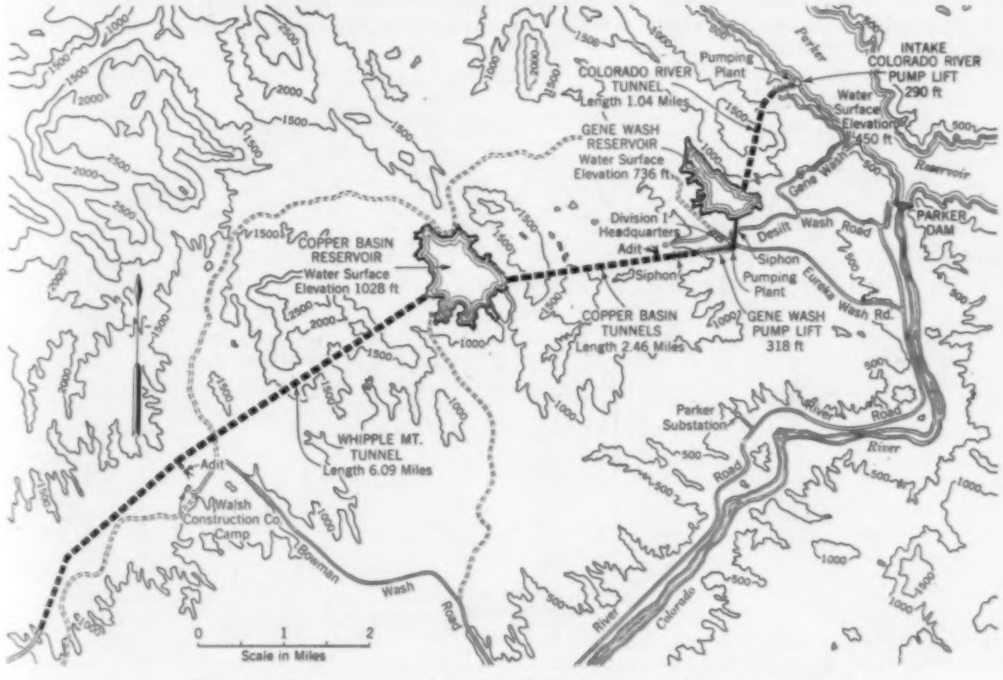


FIG. 3. INTAKE AND RELATED STRUCTURES AT PARKER DAM

Funds for the construction of the aqueduct are to be derived from the $220,000,000 bond issue authorized by popular vote in September 1931. State law requires that the validity of such a bond issue be established by court action before bonds are offered for sale, and the resulting legal procedure consumed a period of sev-

eral months. During this time, preliminary financial arrangements were made, final location of the aqueduct was completed, and plans and specifications were prepared for those parts which were to be started first. In 1932 arrangements were completed with the Reconstruction Finance Corporation for a loan of $40,000,000 with which to get the work under way. An additional loan of $15,000,000 from the Reconstruction Finance Corporation was secured in the fall of 1934 and also a loan and grant of $2,000,000 from the Public Works Administration for use in starting Parker Dam.

The eastern section of the aqueduct lies in a desolate region in which there is no water or any of the ordinary facilities for living and carrying on the required construction work. To require each contractor to provide his own utilities independently would have caused a wasteful duplication of facilities and greatly increased the cost of the aqueduct to the District. Therefore, before construction could be started on the desert sections, it was necessary for the District to build 148 miles of surfaced highway, 471 miles of high-voltage power lines, 1,049 circuit miles of telephone lines, and 180 miles of water supply lines.

Water is secured from wells at the Colorado River and at other widely separated points along the aqueduct, and is furnished by the District to the contractors at prices stipulated in the specifications. Power for construction purposes is purchased by the District from the three local power companies and sold to the contractors at about 1 cent per kwhr. Along those parts of the aqueduct where no other highway is available, a main highway has been constructed and is being maintained by the District for the free use of its own construction forces and those of the contractors.

CONSTRUCTION OF THE MAIN AQUEDUCT

Specifications for the San Jacinto Tunnel were issued in October 1932, and bids were opened in November. This was the first unit of the main aqueduct to be advertised. The construction of the tunnels in the Coachella Division by force account was authorized in December 1932, and specifications for other tunnels were issued in rapid succession. Thus early in 1934 all the tunnels were under contract or scheduled for force account construction.

With one exception, all the work, both contract and force account, has been going forward with remarkable rapidity. Many records for speed, efficiency, and safety have been broken, both on force account and on contract work. Up to January 1, 1935, 56.1 miles of tunnel had been excavated out of a total of 91.9 miles. The only unit on which progress has not exceeded expectations is the San Jacinto Tunnel where, owing to a combination of circumstances, the contractor has not kept the work up to schedule. All the efforts of the District and of the contractor are being concentrated on this tunnel at the present time. It is believed that the difficulties encountered are being met and that any inadequacies which may have existed in the original plan of procedure are being removed. Thus it is expected that this tunnel will be completed within the time originally estimated.

Recently specifications have been issued to cover the open canal, the cut-and-cover conduit, and the siphons of the entire main aqueduct from the Colorado River to the terminal reservoir at Cajalco. Contracts have been awarded for all this distance. Also, the diversion dam at Parker is under construction by the U. S. Bureau of Reclamation. The pumping plants and the electrical transmission lines from Boulder Canyon are yet to be advertised, as are also the Cajalco Reservoir and a few miscellaneous features along the aqueduct.

Contracts have been awarded for the construction of the tunnels into and out of the San Gabriel Canyon, for the tunnels on one of the feeder lines, and for a tunnel along Mountain Street in Pasadena. As of January 1, 1935, this is the only work authorized on the distribution system. However, final location of what is known as the upper feeder line is expected to be completed at an early date, and part of this work will be begun during 1935. It is also planned to complete the designs for a storage reservoir at Cajalco in the near future.

On January 1, 1935, the entire Colorado River Aqueduct project was approximately 20 per cent completed. No difficulties can be foreseen that might prevent completion in 1938 at a total cost of from $12,000,000 to $20,000,000 less than the bond issue estimates.

From the moment of its inception as a governmental

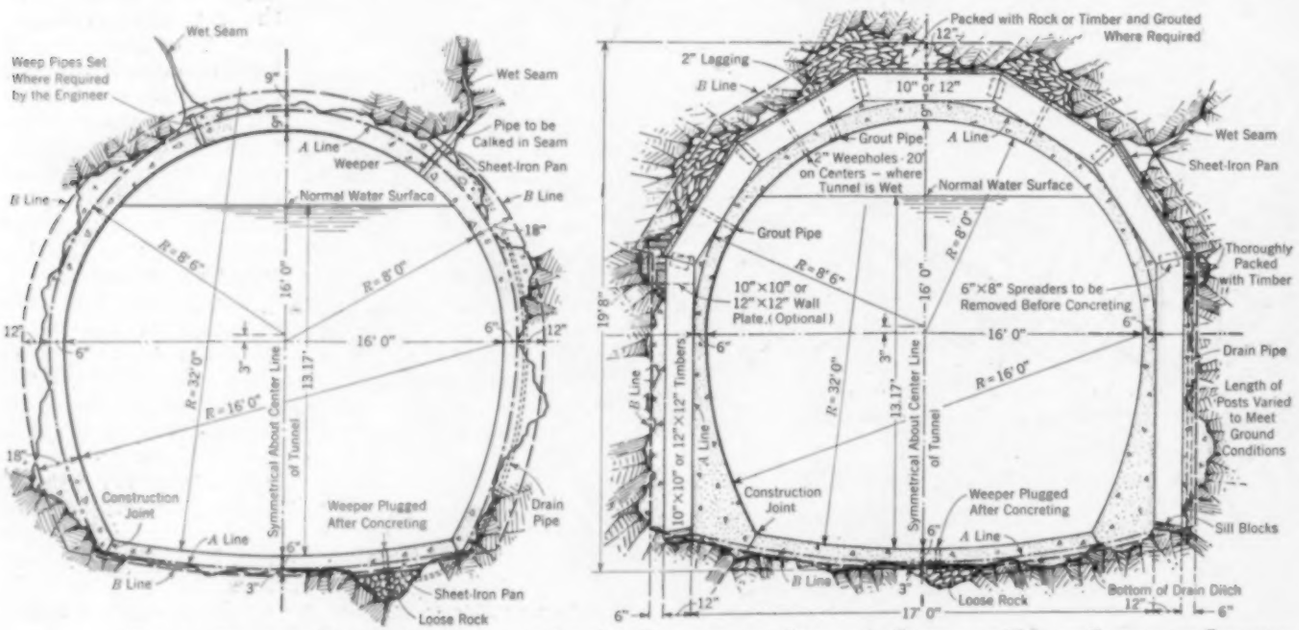


FIG. 4. STANDARD TUNNEL SECTIONS: AT LEFT, IN UNSUPPORTED GROUND; CENTER, IN TIMBER-SUPPORTED GROUND;

Erecting a Pre-Cast Pipe Siphon

One Barrel of a Double-Barreled Siphon Connecting Sections of Closed Conduit

Interior Forms for Fan Hill Siphon

VARIOUS PHASES OF SIPHON CONSTRUCTION ON THE COLORADO RIVER AQUEDUCT

organization, the Metropolitan Water District of Southern California has jealously safeguarded its work against the efforts of those who would seek to control and use the District for selfish purposes. The Board of Directors and the management of the District have maintained that political preferment and special privilege have no place in the affairs of the District, and such influences have played no part in the conduct of the District's business. Technical and clerical employees are selected on a strict merit basis. Competitive examinations are not held, but all applicants are required to submit complete statements of their qualifications sufficiently far in advance of employment to permit careful classification and grading. The final selection is based on an oral examination by a personnel board of qualified District officers. This system has given excellent results. Laborers and other construction employees are selected with the same impartial care. A total of 120,000 applications have been filed and classified, and every effort has been made to eliminate favoritism.

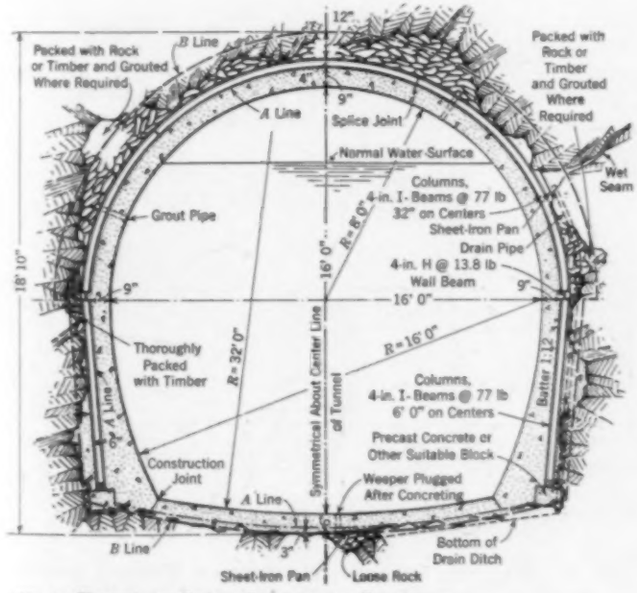
Design of Hydraulic Structures

By JULIAN HINDS

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

ASSISTANT CHIEF ENGINEER, THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA, LOS ANGELES, CALIF.

DESIGN work on the Colorado River Aqueduct covers a very wide field and embraces many interesting problems and structures, a full description of any one of which would occupy considerable space. Consequently the notable work being done by the mechanical and electrical sections, and the important economic factors in connection with the design of the aqueduct proper, must be omitted and only the most usual of the aqueduct structures described.



AND AT RIGHT, IN STEEL-SUPPORTED GROUND

A map and profile of the line are shown in Fig. 1. Except for a few special structures, detail plans are now completed for all of the main aqueduct, from the diversion dam on the Colorado River at Parker to the proposed terminal storage reservoir at Cajalco. However, some design work remains to be done on the pumping stations and transmission lines.

PARKER DIVERSION DAM

Geographically speaking the first structure on the aqueduct, and one of the most interesting, is the Parker Diversion Dam, located just downstream from the mouth of the Bull Williams River, about 18 miles north of Parker, Ariz. The dam will raise the water level 72 ft, thereby creating a regulating and clarifying reservoir with a capacity of 716,000 acre-ft, and making possible the generation of approximately 80,000 kw of electrical energy. The river channel at the dam site is narrow and the rock is good, but unfortunately bedrock at the deepest point is 250 ft below the river bed. An arched type of dam is proposed, as shown in Fig. 2. Unusual features are the great depth of the excavation and the provision on the crest of the spillway for gates 50 ft deep.

The quantities for the principal construction items are:

Tunnel excavation	109,000 cu yd
Open-cut excavation	2,265,000 cu yd
Earth fill for cofferdam	438,000 cu yd
Concrete	305,000 cu yd
Gates and machinery	2,460 tons
Reinforcing steel	940 tons

Plans for this structure were prepared by the U. S. Bureau of Reclamation in Denver, and the dam is being built

CONTRACTOR'S DESERT CAMP FOR CANAL CONSTRUCTION
Wood and Bavenda Company

as a Federal project under a contract with the Six Companies, Inc.

In Fig. 3 the general arrangement of the aqueduct and its related structures in the vicinity of the intake may be seen. The small reservoirs in Copper Basin and Gene Draw are formed by arched dams in rather narrow canyons, and have storage capacities of 20,700 acre-ft and 6,300 acre-ft, respectively. They will assist in regulating the discharge from the first two pumping plants and under some circumstances may serve as clarifying basins. Final plans for these dams have not been completed. There are no other dams on the main aqueduct; the 80,000 acre-ft storage basin at Hayfield is a natural one, and the Cajalco Reservoir is considered as a part of the distributing system.

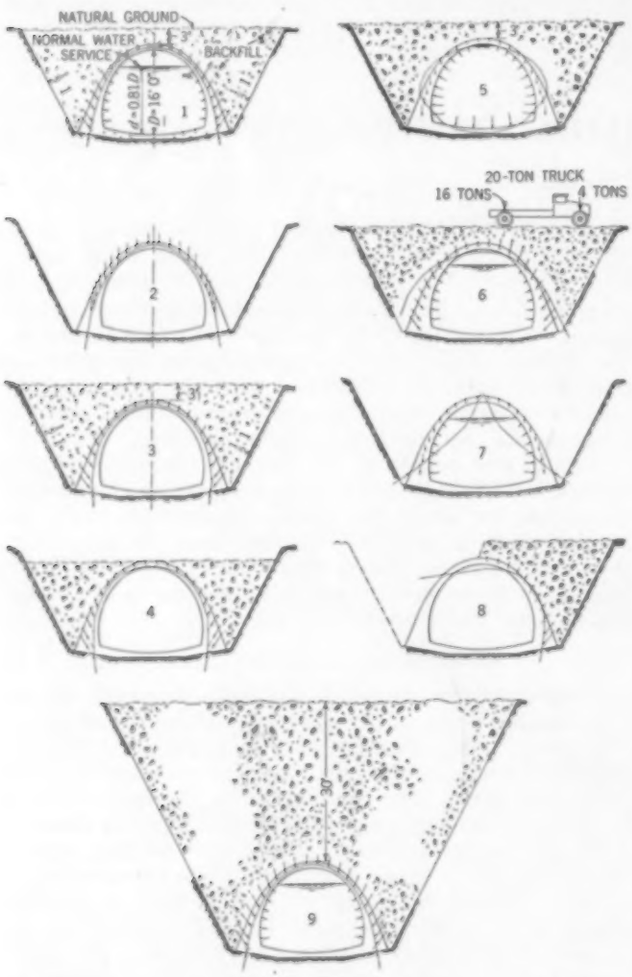
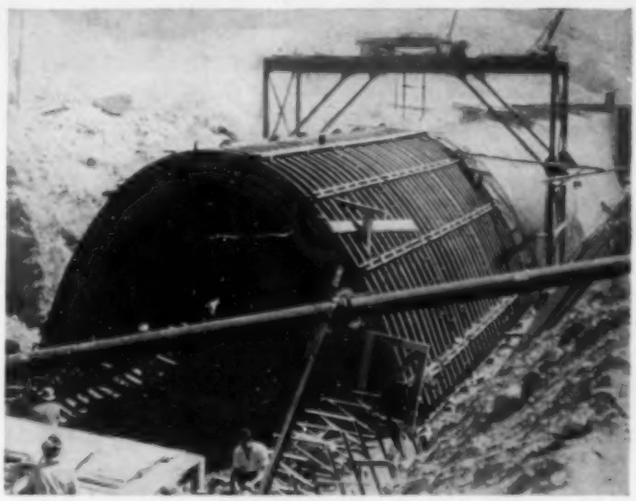


FIG. 5. VARIOUS LOADING CONDITIONS FOR CUT-AND-COVER CONDUIT

HYDRAULIC CHARACTERISTICS OF TUNNELS

With the exception of the Valverde and Bernasconi tunnels at the western end of the line, all the main



POURING ARCH OF CUT-AND-COVER CONDUIT

aqueduct tunnels are of horseshoe shape, 16 ft in diameter, and have a hydraulic slope of 0.00065. The invert is laid to a 32-ft radius, except in soft material, where the radius is 16 ft. Typical cross sections in unsupported, timbered, and steel-supported ground are shown in Fig. 4. Extensive use has been made of steel support, both of the conventional pressed-plate type and of a new combination type utilizing timber lagging on I-beam arches.

Like other parts of the aqueduct, the tunnels are de-

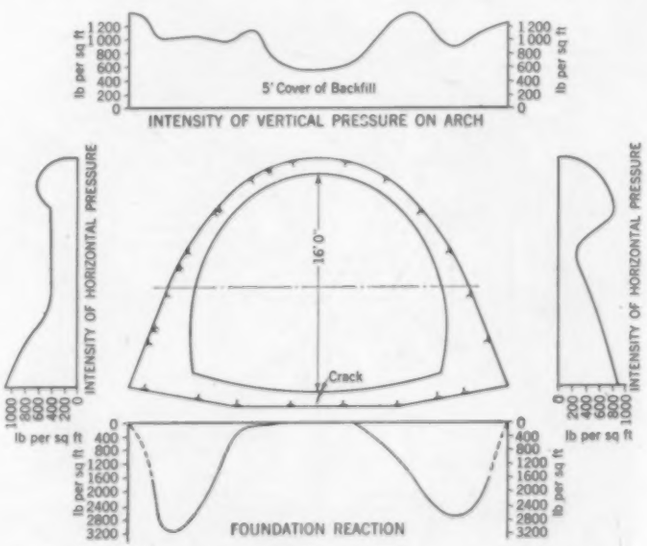


FIG. 6. OBSERVED LOAD DISTRIBUTION ON CONDUIT SECTION
Full-Size Test Conducted at Fan Hill with 5 Ft of Backfill

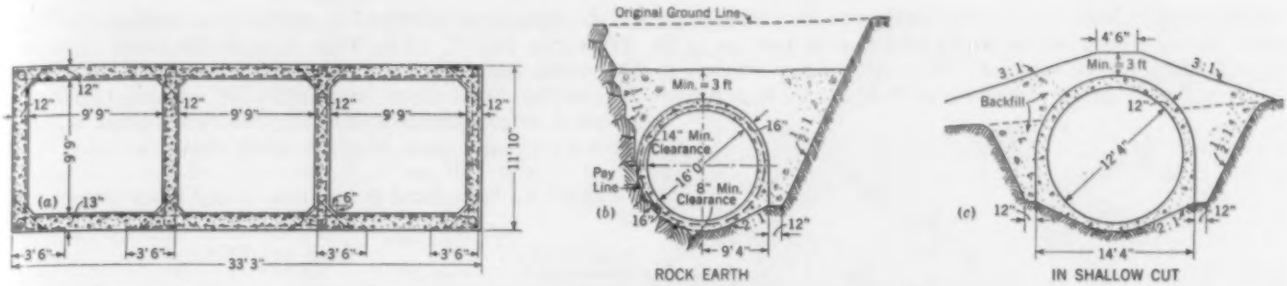


FIG. 7. TYPICAL MONOLITHIC SIPHON CONSTRUCTION

(*a*) Three-Barreled Rectangular Type for Short Lengths Between Open Canals. (*b*) Single-Barreled Circular Type for Short Lengths Between Closed Conduits. (*c*) Double-Barreled Circular Type for Lengths Beyond 300 Ft; Second Barrel to Be Added When Greater Capacity Is Needed

signed for a flow of 1,605 cu ft per sec, which provides for the ultimate average available flow of 1,500 cu ft per sec, with an allowance of 7 per cent for shutdowns. The flow is computed from Manning's value of 0.013 for *n*. Slope and size have been selected to give the smallest possible combined construction and capitalized operating cost. The site of the San Jacinto tunnel marks the controlling divide, which determines the general elevation of the aqueduct. Economic conditions change at this point, and for this reason the tunnels to the west have a diameter of 15 ft 3 in. and a hydraulic slope of 0.00085.

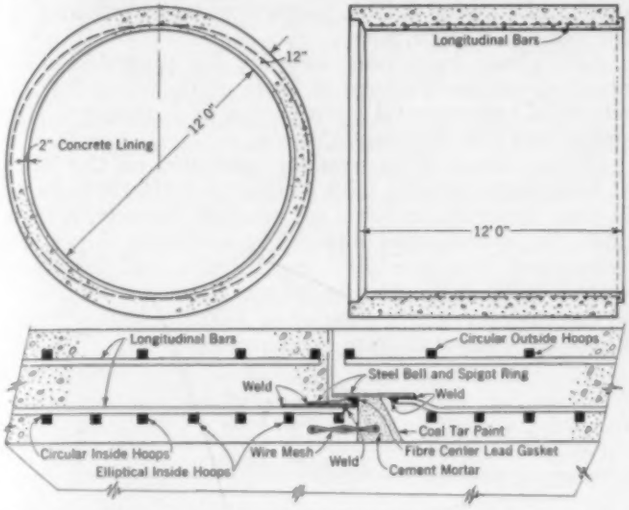


FIG. 8. DETAILS OF PRE-CAST CONCRETE SIPHON PIPE FOR HEADS UP TO 120 FT

For Heads Above 80 Ft a Steel Cylinder Is Embedded in Pipe Shell

In Fig. 4 are shown the sections used in solid and broken rock or in relatively stable alluvium. All of the 29 tunnels on the aqueduct are in rock except the two at Whitewater River and isolated sections of a few others. However, there is a fairly large percentage of broken formations, and short reaches of heavy ground requiring special support are occasionally encountered. Reinforced sections have been designed to meet such conditions.

Cut-and-cover conduit of the type illustrated in Fig. 1 is used on all contour locations between Hayfield and Cajalco and for the more exposed part of the surface line between Hayfield and the intake. Like the tunnel, this section has a nominal diameter of 16 ft but has a larger cross section and a flatter slope. The hydraulic properties are shown in Table I. The section has been designed to be practically free from tension under normal loading conditions and to stand under the variety of conditions illustrated in Fig. 5. Transverse construction joints, which occur at 35-ft intervals, are provided with $^3/_{16}$ by 8-in. steel water stops. In the 700-ft experimental length constructed in the early part of 1934 at Fan Hill, loadings numbered 2, 3, 4, 7, and 8 in Fig. 5 were checked, and the design was found to be adequate. However, the observed load distributions differed more or less distinctly from the corresponding assumed distributions. Typical horizontal and vertical load distributions, as determined from experiment, are shown in Fig. 6.

A large part of the eastern half of the line lies across desolate but comparatively smooth desert and is composed of concrete-lined open canal. This type of structure is much cheaper to build than cut-and-cover conduit and because of its flatter slope requires less pump lift. The general dimensions are shown in Fig. 1, and the hydraulic properties are given in Table I. The slope of 0.00015, which is steeper than the theoretical economic gradient, is required to give such velocity as will keep in motion the sand which it is expected will blow into the canal. The canal section is generally in well-drained, stable alluvium. The 8-in. maximum thickness of concrete lining is designed for maximum water-tightness and durability under desert conditions. There are to be no contraction joints. The 0.5 per cent of high

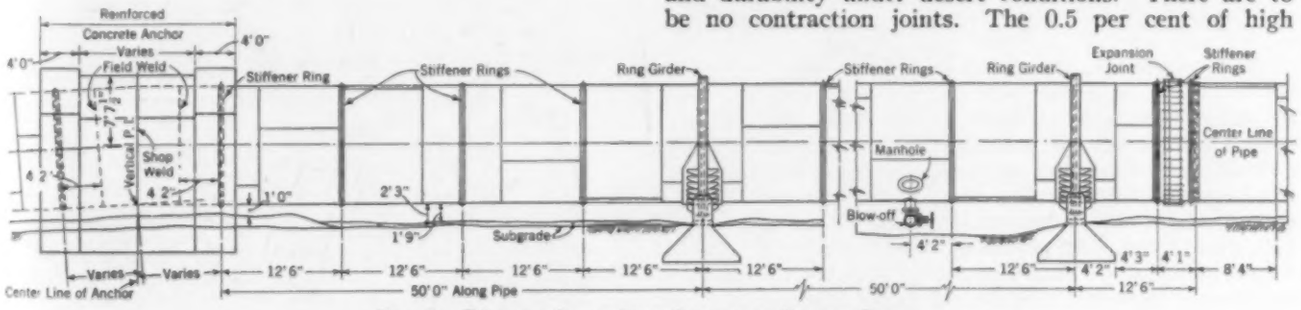


FIG. 9. WELDED STEEL-PIPE SIPHON AT FREDA, CALIF.

Typical Elevation for Pipe 12 Ft 8 In. in Diameter

elastic longitudinal reinforcing steel is to be continuous through all construction joints and is designed to take up all temperature stresses. For safety, the section is to be set well down in the ground, and ample training

DRAG-LINE EXCAVATOR ON CANAL CUT

ditches the protective embankments will be provided to guide storm waters to prepare crossings. A roadway for inspection purposes will occupy one bank of the ditch.

In all, there are to be 150 inverted siphons between the intake and Cajalco. These are required across depressions and drainage channels and vary in length from 125 ft to 26,300. The heads range to a maximum of 151

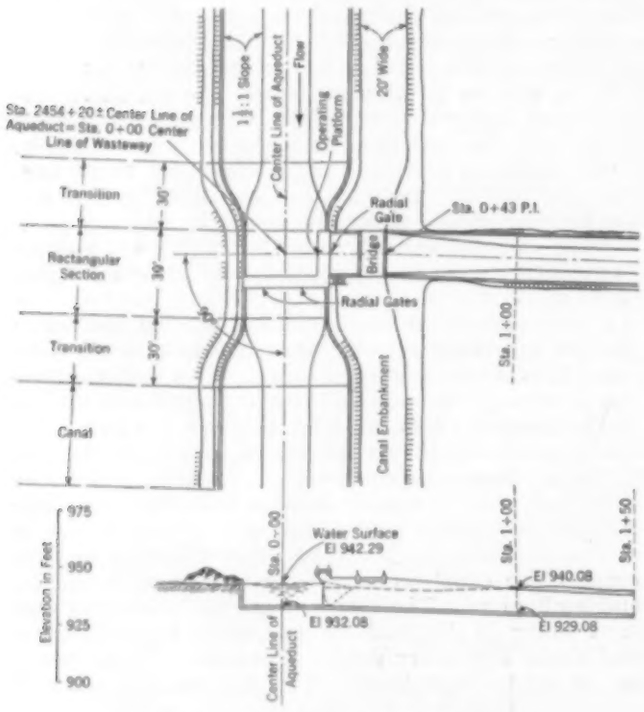


FIG. 10. WASTEWAY AT RICE, CALIF.

ft but are usually much lower. These siphons generally consist of two parallel circular barrels, one to be built now and one when required at some future time. Where the length is 300 ft or less and the head is under 25 ft, the advantages of two-barrel construction are overbalanced by the cost of the bifurcated transition structures at the ends. Such siphons are built as single circular barrels, except where the adjacent aqueduct is open canal, in which event a three-barreled rectangular type, constructed as a single unit, is used.

A typical three-barreled rectangular siphon is illustrated in Fig. 7. This type is used for short stretches between canal sections to avoid the more elaborate transition structures required for other types. A typical single-barreled, circular, poured-in-place siphon, and a typical double-barreled structure are also included

TABLE I. HYDRAULIC PROPERTIES OF AQUEDUCT CONDUITS

ITEM	TUNNEL	GRADE CONDUIT	LINED CANAL
Area, A, in sq ft	191.11	223.43	360.57
Velocity, V, in ft per sec	8.40	7.18	4.45
Discharge, Q, in cu ft per sec	1,605.0	1,605.0	1,605.0
Hydraulic radius, r, in ft	4.89	5.10	6.35
Coefficient of roughness, n	0.013	0.013	0.014
Slope, s	0.00065	0.00045	0.00015

in Fig. 7. The rectangular and the single-barreled circular types are designed for poured-in-place construction only. On the longer siphons, alternative plans for pre-cast and poured-in-place construction were included in the calls for bids. Also, on four important lines, two of which are crossed by active earthquake faults, quotations on steel lines, supported on ring girders above the ground, were requested. On the lines across earthquake faults, flexible joints were to be provided in the poured-in-place pipe.

All siphons have been awarded for poured-in-place construction, on the basis of lower costs, except for the advanced experimental construction of a 12-ft pre-cast siphon at Little Morongo Canyon.

Friction losses in siphons are computed on the basis of Manning's formula, with n equal to 0.013 for poured-in-place concrete, to 0.012 for pre-cast concrete, and to 0.014 for welded steel pipe. The economic slopes are determined from combined construction and operating costs. Inlet and outlet losses are taken, respectively, as 0.1 and 0.2 of the change in velocity head. Bend losses are computed from the equation:

$$f_b = 0.25 \frac{v^2}{2g} \sqrt{\frac{\Delta}{90}}$$

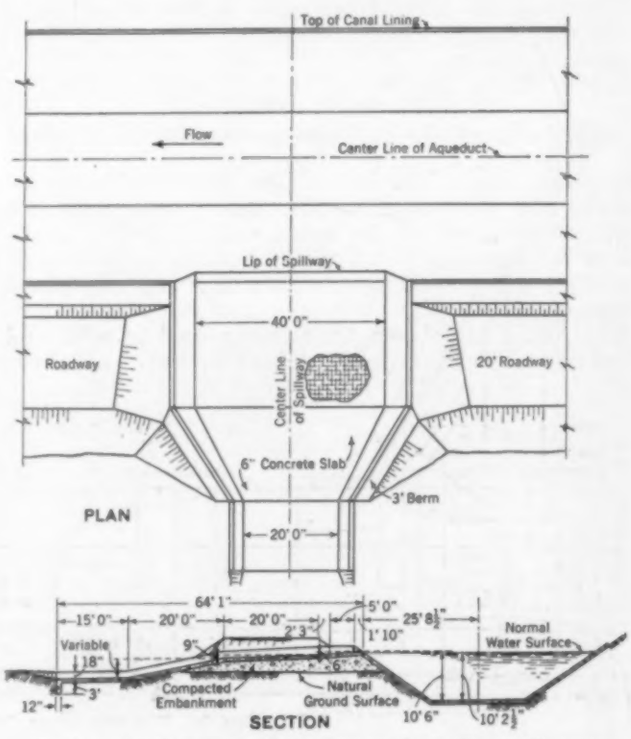


FIG. 11. AN OVERFLOW SPILLWAY IN OPEN CANAL SECTION

in which f_b is the head lost in a given bend and Δ, the angle of bend, in degrees.

Poured-in-place, double-barreled siphons are 12 ft 9 in. in diameter between canal sections and 12 ft 4 in. between tunnel or conduit sections. The corresponding pre-cast sizes are 12 ft 4 in. and 12 ft. The single-barreled circular siphons are 16 ft in diameter.

Typical details of a pre-cast siphon 12-ft in diameter, installed at Little Morongo, are given in Fig. 8. This design provides that the sections be laid in a concrete bed and connected by lead-caulked joints. For heads in excess of 80 ft, a water-tight welded steel cylinder is embedded in the pipe shell, 2 in. from the inner surface. The trial installation of a 723-ft siphon to be operated under a maximum head of 121 ft, at Little Morongo, was entirely successful.

Typical details of an alternative steel design for the Freda siphon may be seen in Fig. 9. The total length of 15,540 ft is divided into 19 sections, with expansion joints and anchors. The ring girder supports are 50 ft apart and are planned to slide directly on the piers. A $^3/_8$-in. shell thickness is proposed throughout, the joints to be welded. The specifications provide for the building of an experimental section of such pipe, from which the need for stiffeners, the spacing of ring girders, and other details, may be checked. Two coats of red lead and one of aluminum are specified for all exposed steel surfaces, and a bituminous coating for the interior.

The aqueduct crosses three earthquake faults that are classed as active: those of Mission Creek, San Andreas, and San Jacinto. Because of possible movement, flexible lines, under pressure, are considered desirable. Welded steel and pre-cast concrete are judged suitable for these crossings. Also, an articulated poured-in-place concrete pipe design, with joints at 20-ft intervals, has been developed as an alternative. The joints are to be closed by $^3/_{16}$ by 8-in. steel water stops for low heads, and by the regular lead and steel joints shown in Fig. 8 for the higher heads. In the case of the flat steel water stops flexibility is assured by a heavy bituminous coating on the plate. Under competitive bidding the articulated monolithic type of construction was adopted for all these crossings.

CONTROL OF FLOODS AND WASTE WATER

Except at the pumping plants, there is little occasion for controlling the flow between the intake and the Cajalco Reservoir. Consequently, the only special structures required along the line are bridges, wasteways, spillways, and sand traps. A wasteway to be constructed at Rice is shown in Fig. 10. This structure

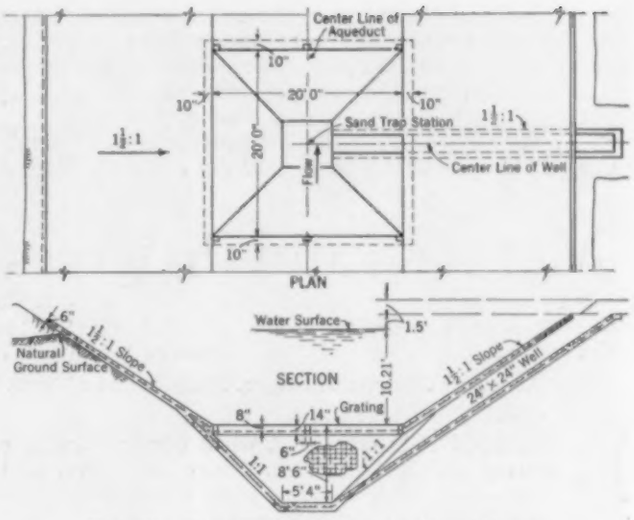


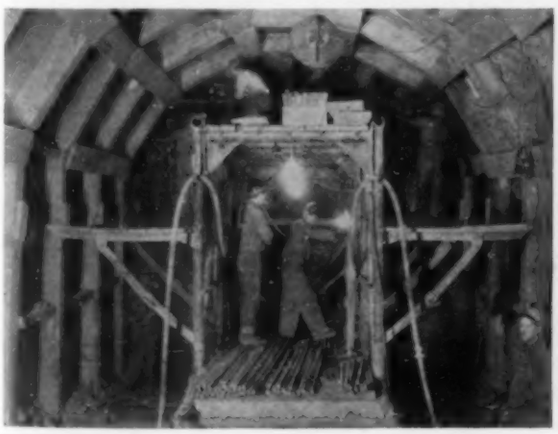
FIG. 12. SAND-TRAP DESIGN FOR OPEN CANAL
Traps to Be Placed About a Half-Mile Apart in Regions of Wind-Blown Sand

is to be operated only in case of a serious failure in the aqueduct. Flow down the aqueduct is stopped by closing the two 17 by 11-ft radial check gates, and the water is discharged through the 20 by 11-ft waste gate. The wasteway channel is concrete lined for a distance of 700 ft, and the water is then discharged into a natural desert channel. Provision of wasteways is made difficult by the scarcity of natural channels capable of safely carrying the aqueduct flow. In addition to the one at Rice, others are to be provided at each pumping plant and at other strategic points. It is necessary to provide a spillway just ahead of each pumping plant to discharge the flow automatically in the event of an interruption in pump operation. These spillways are to be designed as part of the pumping plants.

Although the open lined canal is to be well protected with drainage ditches and dikes, it is possible that limited surface flows may be intercepted during heavy storms. To prevent the dangerous accumulation of such flows, paved depressions in the canal banks are to be provided at intervals, somewhat similar to the standard "dips" of secondary western highways. In Fig. 11 is shown a typical spillway of this type, having a discharge capacity of about 200 cu ft per sec when the water surface in the canal is 18 in. above the crest. The crests are to be 6 in. above the normal water level in the canal. In all, there are to be 12 structures of this type, located at points where the overflow will do no damage.

Storm waters entering the canal will necessarily bring in appreciable quantities of debris. Even though storms capable of breaking down the defensive drainage structures may occur at rare intervals, no special provisions for handling the debris thus brought in are considered justifiable.

The canal passes through several areas of dry sand where a more or less constant deposition of wind-borne material may be expected. Because of the flatness of the country, the depth the canal is set into



DRILL CARRIAGE AT WORKING FACE OF TUNNEL

OPERATING AN AUTOMATIC DRILL

the ground, and the value of the water, removal of this sand by settling pits and wasteways will be expensive. However, such disposal must be resorted to at the intakes of the inland pumping plants. Large desilting structures at these points are now being planned.

To assist in removing the heavier particles of sand, traps of the type shown in Fig. 12 are to be distributed along the open section in the vicinity of these areas of drifting sand at intervals of about half a mile. These pits are to be covered with a grating, designed to slow down the bed load and encourage its deposition. Because of the difficulties previously mentioned, it is proposed to remove these accumulations by means of a portable excavator operating through the well.

Methods and Progress of Tunnel Construction

By J. L. BURKHOLDER

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

ASSISTANT GENERAL MANAGER, METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA, LOS ANGELES, CALIF.

BETWEEN February 1933, when construction was started on the Colorado River Aqueduct, and January 1, 1935, the tunneling forces have excavated 56 miles of the total of 92 miles of tunnels. Since May 1934, tunnel progress was averaged more than four miles per month. The size of this undertaking can be appreciated by a study of Table I, which lists the estimated total quantities involved in the various types of construction.

TABLE I. TYPES OF WORK AND ESTIMATED TOTAL CONSTRUCTION QUANTITIES FOR COLORADO RIVER AQUEDUCT

In Cubic Yards

TYPE OF WORK	LENGTH IN MILES	EXCAVATION	CONCRETE
Tunnels	91.9	5,320,000	1,560,000
Open canal	63.4	7,100,000	470,000
Conduit	54.7	9,250,000	1,230,000
Siphons	28.9	3,200,000	365,000

TUNNEL EXCAVATION AND SUPPORT

By the end of 1934, all of the 29 tunnels on the main aqueduct were under construction, 19 being driven by 13 contractors and 10 by the District forces. The construction methods and machinery developed to excavate these tunnels have been a step forward in the art of tunnel driving.

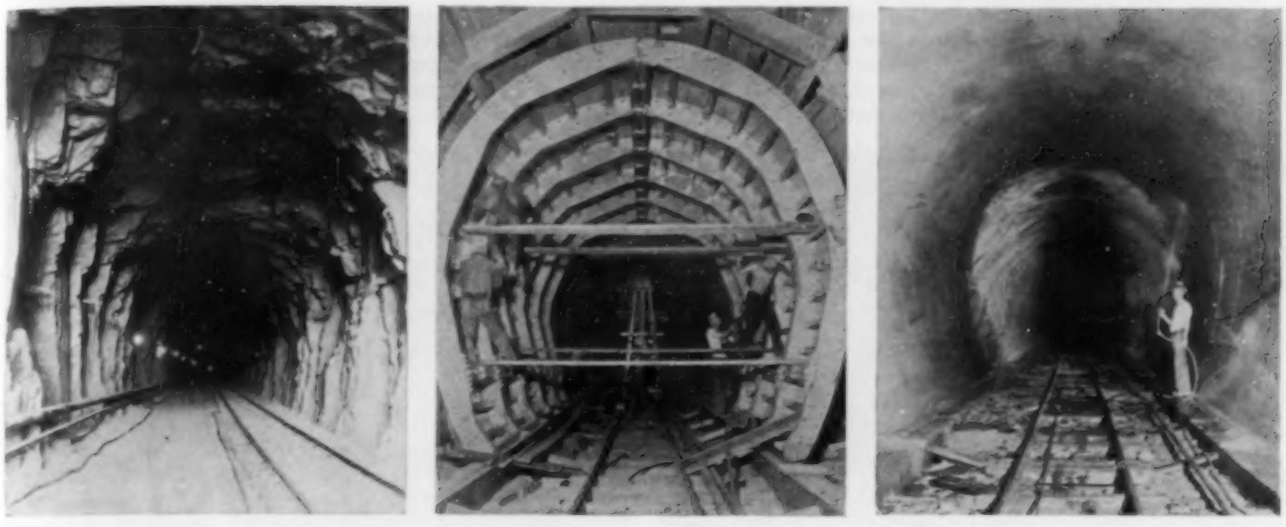
Drilling operations are carried on from double-deck drill carriages or "jumbos" mounted on car trucks that can be pushed to the face by an electric locomotive and towed back out of the firing zone on completion of the drilling. The full face of the tunnel, 16 by 16 ft in size, is drilled by from 4 to 6 drills, which are all of the hammer, air-operated type. These cut the rock one-third faster than the old piston type of a few years ago. Depending on the type of the rock, the usual round of drilling takes from 2 to $3\frac{1}{2}$ hr and consists of from 25 to 60 holes, 4 to 8 ft in depth, which are loaded with 25 to 40 per cent dynamite.

A new device, described by T. W. Osgood, Assoc. M. Am. Soc. C.E., in the January number of CIVIL ENGINEERING, for the protection of the blasting caps has been developed. It consists essentially of a block of wood drilled longitudinally to contain the primer and to protect it from contact with the sides of the drill hole, and at the same time to make the detonation positive. This device has eliminated the hazard of premature explosion while loading. The sequence of firing is obtained by the usual "delay" primers, allowing the whole round of holes to be detonated in correct order.

After the round of holes is fired, the time required to clear the heading of smoke is only about 30 min. The shortness of this period is made possible by means of improved ventilation plants of large capacity, which are reversible in operation. First the smoke and gases are withdrawn from the heading and then fresh air is forced to the face while mucking operations are in progress. The ventilating pipe is usually 22 in. in diameter and has special rubber gasketed joints to reduce leakage. The ventilating plants have a capacity sufficient to completely replace the air in the 20-ft length of tunnel adjacent to

THE CALIFORNIA SWITCH, A PASSING TRACK SUPERIMPOSED ON THE SINGLE TUNNEL TRACK

Left, in a Timber Supported Tunnel; Right, in a Tunnel Supported by Steel Ribs and Wooden Lagging

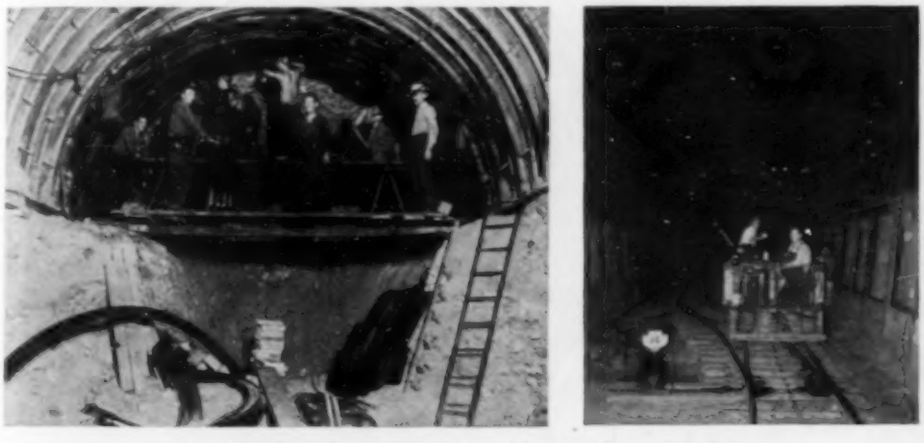


FINISHED TUNNEL SECTIONS

Left: Typical Unsupported Rock Section, with Ventilation Pipe 22 In. in Diameter Suspended from Roof and, at Lower Left, 6-In Compressed-Air Line and 2-In. Water Line. Middle: Placing Concrete Forms for Tunnel Lining in a Timber-Supported Tunnel. Right: Concrete Arch Section Completed

the working face, every minute for a short period after firing, and have a normal air-replacement capacity of one-half this amount during the mucking and drilling cycles.

Of the total tunnel footage 58 per cent is supported and 14 per cent is coated with gunite. The remainder requires no support or protective lining. There are three types of tunnel support in use: the timber, the steel, and the steel-rib type lagged with wood, which was developed on this work by the District forces. Gunite is used to a large extent as a coating on certain types of rock structure which disintegrate on exposure to the air.



TYPICAL STEEL-SUPPORTED TUNNEL SECTIONS

Left, Placing Steel Liner Plates in Whitewater Tunnel No. 2; Right, Storage Battery Locomotive in a Finished Steel-Supported Tunnel

AUXILIARY PLANTS AND FACILITIES

For the tunnel drilling operations, air at a pressure of 100 lb per sq in. is furnished by compressor plants which have a capacity of 1,500 cu ft per min for single headings and 2,000 cu ft per min for double headings. These plants are electrically driven and deliver the air to the headings through 6-in. pipes. The drill-sharpening shops are usually located near the tunnel portals and are equipped with oil furnaces and air-operated steel sharpeners. Several automatic heat-treating plants have been installed with excellent results. The most advanced of these is the District's central steel shop, which furnishes steel for all the District tunnels, and in which marked economies in production have been attained. The average cost of these tunnel plants is $125,000 for a single heading and $250,000 for a double heading.

After careful study of climatic conditions, camps for housing and feeding the workmen were built and equipped with temperature-controlled sleeping and mess facilities, which give a maximum of comfort to the men. The cost per camp, including all facilities, has averaged $45,000. Each camp accommodates from 80 to 125 men.

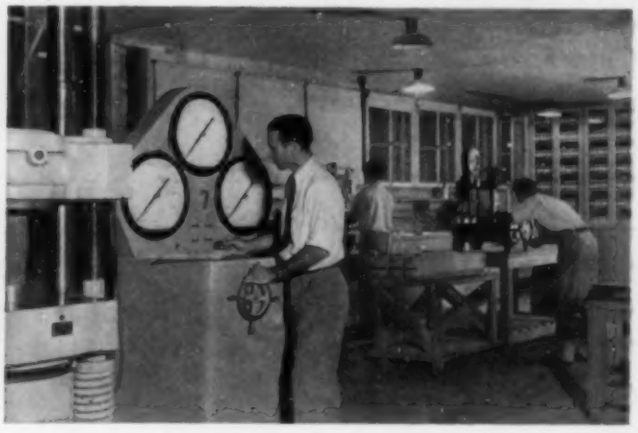
The contractors require each man, before employment, to be examined by the resident physician to determine his fitness. First-aid stations are maintained to give immediate emergency treatment to the injured, and there are two fully equipped hospitals, one at West Eagle Mountain and the other at Berdoo Camp of the District. These hospitals have a staff of doctors and nurses in attendance and maintain ambulance service.

A safety engineer and a staff of assistants make safety inspections both on the work being done by the District and on that under contract. A safety program has been conducted through training and first-aid classes, safety clubs, and committees, where hazards are discussed and safety measures developed. All the tunnel superintendents have fully cooperated, so that the accident frequency rates have dropped and are still dropping markedly. Safety flags and emblems have been awarded to the camps having the best record for safety each month with very beneficial results in the lowering of the

number of accidents. The U. S. Bureau of Mines has furthered the program by sending a representative to give the men courses in mine rescuing and first aid.

A material testing laboratory in charge of a testing engineer and assistants is maintained by the District at Banning, where preliminary investigations of materials and methods of handling have been conducted for all materials used in the work and where these materials are tested for acceptance before delivery. In connection with the concrete work, the laboratory has located and tested 60 sources of concrete aggregates and has made exhaustive tests of cements for resistance to alkalis, of concrete compositions to withstand desert conditions, and of the relative value of sealing compounds to be applied to the concrete to prevent evaporation of mixing water during setting. Test specimens are taken from the concrete placed by each shift on every job, and members of the laboratory staff are in constant touch with the field work in order to obtain uniform standards throughout.

AQUEDUCT RESCUE SQUAD AND ITS EQUIPMENT



THE DISTRICT'S CEMENT TESTING LABORATORY AT BANNING, CALIF.

TABLE II. TUNNEL DRIVING RECORDS TO JANUARY 1, 1935

		AVERAGE RATE PER DAY
Day Record:		
In cemented gravel, by the West Construction Company in Whitewater Tunnel No. 1	49 ft	
In rock, by District forces in the west heading of Seven Palms Tunnel, August 31, 1934. (This record was equaled in west heading of Copper Basin Tunnel No. 2, by the Walsh Construction Company on December 14, 1934.)	54 ft	
Week record:		
In cemented gravel, by the Utah Construction Company in West Iron Mountain Tunnel (7-day week)	315 ft	45 ft
In rock, by the Walsh Construction Company in the west heading of Copper Basin Tunnel No. 2 (6-day week)	284 ft	40.5 ft
Month record:		
In cemented gravel, by the Utah Construction Company in the West Iron Mountain Tunnel (7-day week)	1,027 ft	34.2 ft
In rock, by the Walsh Construction Company, in the west heading of Copper Basin Tunnel No. 2 (7-day week)	1,084 ft	36.1 ft

OUTSTANDING PROGRESS RECORDS

With these plants and the improved equipment that has been developed, progress has averaged 523 ft of tunnel per month in a single heading, and for the aqueduct as a whole, 4 miles per month, or 6.9 ft per shift. The outstanding records up to January 1, 1935, are given in Table II.

These records are impressive when it is remembered that the most rapid progress in a single heading made on the Catskill Aqueduct for New York City was 523 ft in a month, and that on the Mountain Division Tunnel of the Hetch-Hetchy Aqueduct, 776 ft in a month.

The work of lining the tunnels with concrete has been started and by January 1, 1935, 10,553 ft of arch lining had been completed. Conduit, canal, and siphon construction amounting to 149 miles, has been let to ten contractors. The first excavation was done by Wood and Bevanda, just east of Iron Mountain, on November 27, 1934. In December three other contractors began excavation. On the remaining contracts, camps are being built and equipment is being assembled.

Tunnel Contractors' Plant and Equipment

By J. C. AGNEW

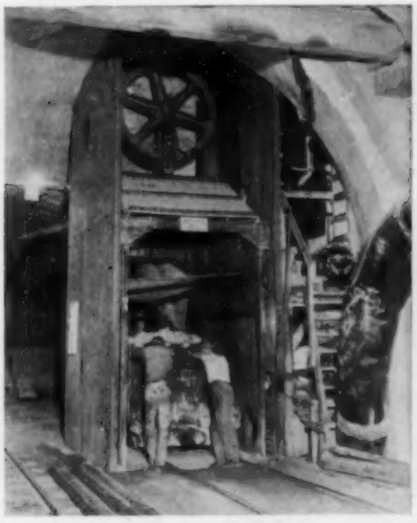
DIRECTOR, WINSTON BROTHERS COMPANY, CONTRACTORS, MINNEAPOLIS, MINN.

IN general, access to the main tunnel bores on the Colorado River Aqueduct is gained in two ways—by adits and by shafts. Adits are the more generally used. The San Jacinto tunnel, 12.77 miles long, and the longest single bore on the aqueduct, is reached at Cabazon by a shaft about 250 ft deep and a cross-cut; at Protrero by a shaft approximately 800 ft deep, intersecting the main tunnel line; and at the west portal by an inclined adit. The Valverde tunnels are approached by one inclined adit and three shallow shafts. The East Iron Mountain tunnel is reached by a shallow shaft.

By reason of the depth of the shafts on the San Jacinto tunnel, the muck coming from the heading is dumped into pockets in the tunnel floor, and passes from them into skips. These are hoisted to the surface and dumped into pockets. There the muck is ready for transportation to the dump by truck and dump cars.

On the Valverde tunnel, because of the shallow depth of the shafts, the cars are hoisted to the surface in a mine cage, uncaged, and hauled to the dump. At the East Iron Mountain shaft, which again is shallow, the cars are hoisted on a cage to a point about 32 ft above the

HEADFRAME AT SHAFT OF EAST IRON MOUNTAIN TUNNEL
Muck Cars Dumped Pneumatically Into a 60-Yd Bunker



MUCK CAR GOING ON CAGE
Bottom of Shaft of East Iron Mountain Tunnel

EAST PORTAL OF COXCOMB TUNNEL, 3.37 MILES LONG
Under Contract with Winston Brothers Company

collar of the shaft and are dumped from the cage into a 60-cu yd rock pocket or bunker by a pneumatic car dumper. The cars are side-dump, and a "downfall" door assures that no large rock will fail to pass out of the car. This is really a development of the self-dumping cage. From the bunker the muck is allowed to fall, through air-operated finger gates, into dump trucks, which haul it to the dump.

MUCKING EQUIPMENT DEVELOPED

Considerable development has taken place in the machinery and methods of removing the broken rock, or muck. As this operation is the limiting factor in the cycle of driving, special efforts have been made to expedite it. Two types of mucking equipment are used in the tunnels—mucking machines and electric tunnel shovels. The conveyor-loader type of mucking machine is in most general use. This machine scoops up the broken rock and deposits it on an elevated conveyor belt, which carries it to a car standing under the rear end of the belt.

FORTIER CONCRETE MIXER AND PLACER FOR TUNNEL LINING
Beginning Operations at a Tunnel Portal

On the West Eagle Mountain tunnel, the Dixon conveyor and drill carriage is used in connection with the Conway mucking machine. The conveyor is 135 ft long, 14 ft wide, and 12 ft high, and is operated by a 10-hp motor. The muck passes from the belt of the mucking machine at the heading to a 42-in. belt traveling the length of the conveyor. A train of 8 cars is backed under the conveyor platform and moves forward as the cars are loaded, leaving the tunnel when the last car is filled. An empty train then moves under the conveyor from a siding near by. The time required for mucking a 6 to 8-ft round by this means is between 2 and 3 hr. The conveyor is also moved up to the face and used as a drill carriage, employing columns for mounting the drills. This is one of the new methods developed for use in tunnel driving and has worked out very satisfactorily.

Two of the tunnel shovels used by the Winston Brothers Company are mounted on rails owing to the hardness of the rock encountered. Each of these shovels weighs 78,000 lb and is operated by 440-v current, with a 60-hp hoisting motor, a 30-hp swinging motor, and a 30-hp crowding motor. The "cherry picker," or car hoist mounted on the back end of the shovel, for transferring empty cars, has a $6\frac{1}{2}$-hp motor. A similar electric tunnel shovel has also been developed which is mounted on tractor treads. Both types have a dipper of $1\frac{1}{4}$-yd capacity.

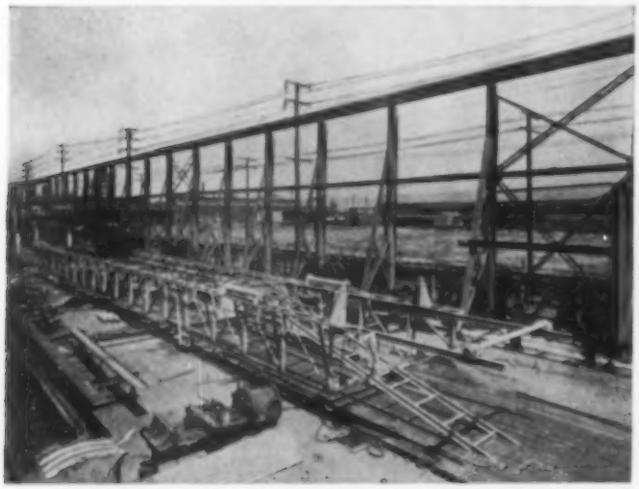
The muck cars are of 4 to 6-cu yd capacity and, coupled in trains of from 6 to 8 cars, are hauled by 6 to 8-ton electric locomotives. These are usually of the storage-battery type, although both trolley and combined trolley and storage types are in use.

CAR-SWITCHING DEVICES

The problem of car switching at the face has brought out a number of new devices developed to replace the loaded car at the mucking machine with an empty one in the shortest possible time. These devices may be classified in two general groups: first, the "cherry picker," or car gantry, which swings the empty car from the track to allow the loaded one to pass and then replaces the empty one on the track to be pushed to the mucking machine; and second, various switching devices to pass the empty and loaded cars. The "cherry picker" types are electrically or air-operated hoists on an elevated running rail or swinging boom. One type hoists the empty car vertically to allow the loaded car to pass under it.

Many of the tunnel contractors use the King car passer, devised by H. J. King of the Hamilton and Gleason Company, contractors on the Bernasconi tunnel, for

setting empty cars at the tunnel heading. This device is 98 ft long, 14 ft wide, 8½ ft high and weighs about 20 tons. An entire train of 6 or 8 empty cars is pulled up a ramp at the rear of the car passer by an electric hoist to a track on the top of the frame. At the front end the cars are lowered one at a time to the tunnel track, in position to be loaded by the mucking machine. As soon as an entire train of empty cars is on the passer, the rear ramp is lifted to clear the track, and the tunnel locomotive moves forward in readiness to withdraw the string of cars after they have been set down on the track and loaded. The whole apparatus runs on rails. The drills are mounted on an overhang at the front end. Also, the upper deck serves as a convenient working platform for placing tunnel timbers, and much of the timber can be hauled on to the deck in the same manner as empty cars are handled.



A KING CAR PASSER DURING ITS CONSTRUCTION
Empty Muck Cars Are Moved Over the Top to Position at the Mucking Machine in the Tunnel Heading

The "California switch" consists of two parallel tracks connected at their ends by switches and built to be superimposed on the single tunnel track, connection with that track being made by short inclines of tapered rail. The whole arrangement is pulled along the tunnel track by a hauling motor or the mucking machine or by both. The time required to shift cars at the heading is from 45 sec to 2 min. The California switch, although not a new device, has been perfected by the District's forces.

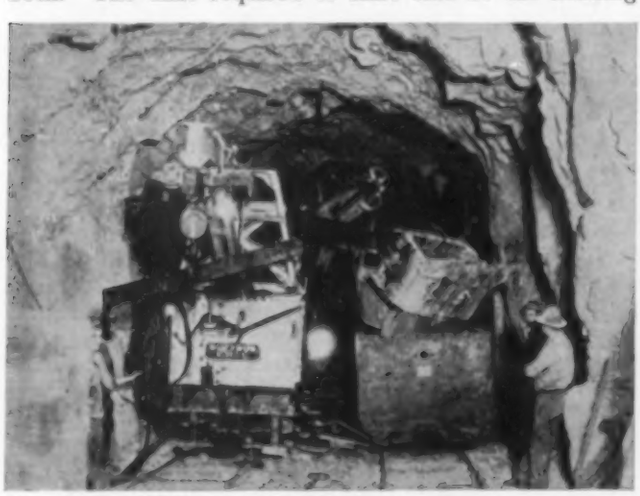
MIXER-PLACER FOR PLACING CONCRETE LINING

On the Mecca Pass tunnel, the contractor, the Morrison-Knudsen Company, is placing concrete lining with a new mixer-placer, invented and developed for the purpose by George Fortier. This machine is a combination of a mixer drum and a concrete gun, the concrete being placed pneumatically direct from the mixer, through a 6-in. pipe, into place behind the tunnel forms. The mixer-placer is designed to handle dry batch concrete, to mix it, and to discharge it through a 6-in. pipe, in batches up to 1.2 cu yd. It consists of a heavy welded steel drum, which is rotated by a 35-hp fully enclosed electric motor. The batched concrete is dumped from batch cars into a hopper at the rear of the mixer-placer and enters the drum through a circular gate operated by an air cylinder.

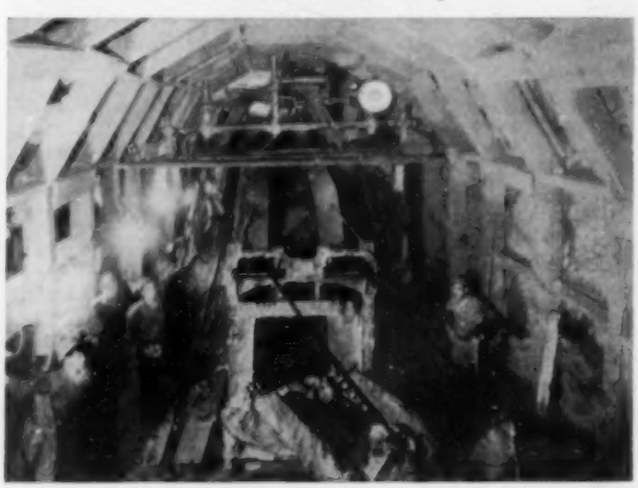
This gate opens inside the drum so that when the air pressure is applied in the drum the gate seats tightly, and the air pressure holds it closed. The drum has three sets of blades which feed the concrete to the front end of the drum, where it is picked up by cup-shaped blades and discharged into a trough over the discharge pipe opening. A specially designed slide gate in the discharge line, operated by an air cylinder, controls the discharge from the mixer-placer. As soon as this machine is charged, both gates are closed and the air pressure is turned on. By the time the pressure is built up in the drum, the concrete has been mixed the required ½ min and is discharged by opening the slide gate on the 6-in discharge line. The air for pneumatically discharging the concrete enters the mixer through a 2-in. pipe at the discharge end of the drum, as does the water pipe.

The first major bore on the aqueduct, the Cottonwood tunnel, was holed through on December 12, 1934, by the J. F. Shea Company. This 3.8-mile tunnel was attacked from each end and was completed just 17 months after work was started, at an average rate of 610 ft per month, on the basis of a 6-day week.

Keen competition exists, not only between the contractors themselves, but also between them and the forces of the District. This friendly and sportsmanlike rivalry has resulted in a rate of progress unequaled on similar work, and the records indicate that safety of life and limb has not been sacrificed to speed.



Winston Brothers Company
ELECTRIC SHOVEL IN EAST COXCOMB TUNNEL, WITH 1¼ YD BUCKET
Crane for Picking up Empty Muck Cars Mounted on Rear of Shovel



DIXON CONVEYOR AND DRILL CARRIAGE, LOOKING FROM THE HEADING
Conway Mucker in Position to Deliver Material to Conveyor Belt

Changes in Lake Levels in Great Basin Area

Three Hundred Years of Record Studied to Determine Trend in Available Water Supply

By S. T. Harding

Member American Society of Civil Engineers
Professor of Irrigation, University of California, Berkeley, Calif.

Particularly in the Southwest, climatic variations are of special interest at present because of the reduction in water supply during recent years in comparison with that of some previous periods. Based on lake levels, about 100 years of actual historic record are available, but Professor Harding has projected this record backward for another 200 years by a study of trees and stumps around the margins of lakes. In a study of the 300 years of lake level history thus derived, he finds no cyclic variations which justify projection into the future, but he definitely concludes that the dryness of the period since 1917 has been exceeded prior to that time; and that water supply plans should be based on meeting demands during periods having a run-off similar to that for the period since about 1917, as it is to be expected that such periods will recur in that region in the future.

Fluctuations in level of the enclosed lakes of the Great Basin reflect the water supply conditions on their drainage areas. Records of such fluctuations include both direct measurement of the elevation of the lake surface, in some cases extending back to 1850, and indirect records obtained from trees growing around the margins of the lakes, some of which extend back to 1650. For several years, as opportunities have presented themselves, I have been collecting data on the past fluctuations of Great Basin lakes. These data have included both field investigations and library research through early accounts by pioneers and engineers regarding conditions on these lakes.

While the results for different lakes vary in extent and definiteness, they are reasonably consistent in their general trends. They have been assembled to give a composite picture of what appears to have been the general character of the water supply of the Great Basin since about 1650 A.D.

Climatic and soil conditions permit the growth of trees around some of these lakes. During periods of deficient run-off, with resulting low lake stages, trees may start on the unwatered lake margin. Such trees live until a rise of the lake submerges them. The age of the tree shows the length of time the lake remained below the elevation of the ground on which it grew. For this purpose only the total age of the tree is required; no attempt was made to measure the thickness of individual annual rings. Narrow rings might indicate either drought and a low lake stage, or ground water too close to the tree, due to a high lake stage. Trees that have been killed by submergence usually break in a few years a short distance above the ground, but their stumps remain well preserved while submerged and for many years after the lake has receded.

Trees Killed by Rise of Eagle Lake
Top of White Area Marks Former High Water Mark

Fluctuations based on historic records have been plotted in Fig. 1. Indicated limiting high stages over a longer period, for those lakes for which tree records were secured, are shown in Fig. 2. The extent and definiteness of the records for each lake will now be discussed.

Fluctuations of Great Salt Lake

Great Salt Lake was surveyed in 1850 by Stansbury and in 1869 by King. Various other observations are available prior to 1875, when direct records began. The fluctuations from 1850 to 1923 are plotted in Water Supply Paper 517 of the U. S. Geological Survey. The extension back to 1845 in Fig. 1 is based on Fremont's description of riding to Antelope Island in that year through water nowhere coming above his saddle girths.

Stansbury observed two storm lines on the lake at about elevations 4,207 and 4,213, U. S. Geological Survey datum. Brush grew down to, but not below, the lower storm line in 1850. In 1877 Gilbert, in J. W. Powell's report entitled *Lands of the Arid Region of the United States with a More Detailed Account of the Lands of Utah* (published by the Government in 1879), describes brush growing above the upper storm line, which is above all recorded lake stages. The lower storm line was submerged in 1877. Gilbert concluded that the lake had probably not been above the lower storm line prior to 1850 for perhaps several hundred years, since a long time would be required after any submergence to leach salt from the soil so that sage brush could grow. In his *Journal of a Trapper*, Osborne Russell tells of wintering near the lake in 1840–1841 and of Indian accounts of going to Antelope Island by raft or by wading. The Indians claimed the lake had been rising.

Diversion of tributary inflow for irrigation in time will be balanced by reduced amount of evaporation due to reduced lake area and reduced rate of evaporation due to increase of salt content with reduced lake volume. About 800,000 acres are now irrigated within the drainage area of Great Salt Lake; the consumptive use of this area probably represents about 30 per cent of the former average evaporation from the lake. General computations of the effect of this diversion indicate that the lake would have been as high from 1923 to 1927 as it was from 1868 to 1878, if irrigation had not increased between these two periods. It is also probable that the lake would not have been as low in 1934 as it was in 1905 had it not been for the same effect.

This information on past conditions on Great Salt Lake supports the conclusion that the stages reached in the two high periods since 1850 were higher than any stages reached for a period prior to 1868. Although the length of this period cannot be definitely fixed from any

available records, it was probably over a hundred years and may have exceeded two hundred years. The low stages since 1850 also appear to have been higher than previous low stages. Great Salt Lake would have been continuously higher since 1850 than for a long time prior to that year if part of the natural inflow had not been used for irrigation.

STAGES OF PYRAMID LAKE

Pyramid Lake receives the run-off of Truckee River. At high stages it overflows into Winnemucca Lake. Irrigation now consumes the larger part of the former inflow, so that lake fluctuations are no longer a direct measure of the total water supply. The earliest record

STUMP IN LAKE TAHOE PHOTOGRAPHED WHEN WATER SURFACE WAS 0.3 FT BELOW ELEVATION OF OUTLET RIM

on Pyramid Lake is that obtained from Fremont's Diary in January 1844. From his account and sketches it has been possible to identify a sufficient number of points on the lake to determine elevation at that time. The lake was relatively low in 1844. Some records are available for 1869 and 1870 from the surveys of the fortieth parallel and, in the early eighties, from Russell's studies of Lake Lahontan. Other records prior to 1910 are scattered; fluctuations between known points after 1871 have been interpolated from rainfall records. General computations of consumptive use indicate that without irrigation diversion, Pyramid Lake would have been higher in 1917 than it was in 1890 with overflow to Winnemucca Lake, and would not now be as low as it was in 1844.

DATA ON LAKE TAHOE

Lake Tahoe has a restricted outlet so that the stage is a partial indicator of the run-off. In some periods the inflow is less than the evaporation, and the water level drops below the rim. Records of elevations are available since 1900, and there are a few earlier readings for 1888–1890 and for 1895–1896. As Lake Tahoe was not on the early routes to the coast, there are few references to it in the early accounts of this area. It has been below its rim for short periods in recent years but has risen above the rim in parts of all years.

Trees have grown within the zone of fluctuation of this lake. Stumps of a tree 100 years old growing on ground 2 ft lower than the rim and of trees 150 years old growing at the elevation of the rim have been found. Indian grinding stones have been taken from near the outlet at about the elevation of the present rim. There are no evidences of recent changes in elevation of the rim. Cutting by erosion at the outlet appears more probable than any filling by deposit of silt or storm-moved gravel.

Although the small range of fluctuation of Lake Tahoe makes it a less positive indicator than the entirely enclosed lakes, its records are similar and add support to the indications of other lakes in the western Great Basin. Lake Tahoe shows a generally high stage from 1890 to nearly 1920 and lower stages in recent years. Tree records indicate past periods of deficiency of greater amount and duration than any within the time covered by direct records.

RECORDS ON EAGLE LAKE

Eagle Lake is a landlocked body of water about 15 miles northwest of Susanville, Calif. Its area at recent high stages has been about 30,000 acres. Prior to 1924 natural conditions around it had not been changed, but in that year it was tapped by a tunnel. The draft through the tunnel has lowered the lake and affected its direct usefulness as an index of run-off. Records of this draft have not been kept by the districts operating the tunnel.

This lake is comparatively recent geologically, as is shown by the relative freshness of its water. It was formed by a lava flow across the course of Willow Creek. Some have thought that springs rising in Willow Creek

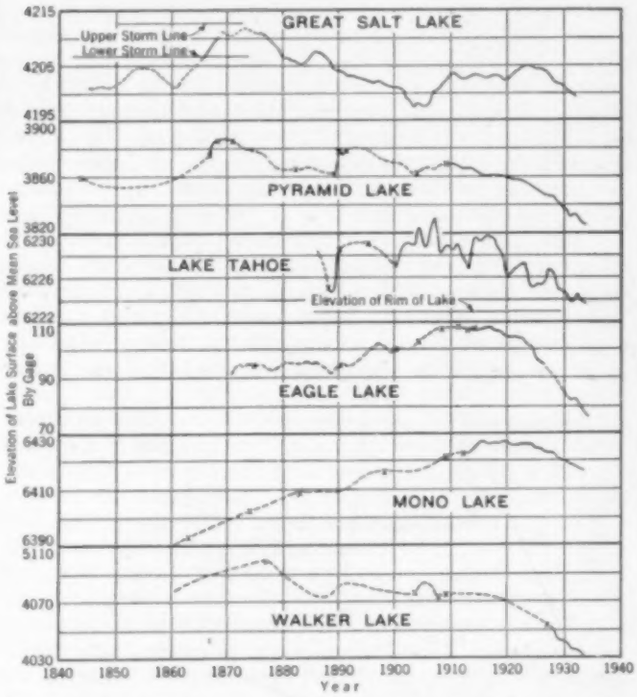


FIG. 1. FLUCTUATIONS OF GREAT BASIN LAKES, BASED ON HISTORIC RECORDS

Where Detailed Records Are Available, Only Seasonal High Stages Are Plotted. Where Records Are Incomplete, Dotted Lines Are Used. Points Representing Records During Periods of Incomplete Observations Are Indicated by *x*

below the lava flow are fed from the lake. This is uncertain, but if the entire flow of these springs came from the lake this flow would represent only about 3 in. of depth on the lake per year.

Direct records begin with the U. S. Land Survey in 1875. Relocation of meander corners indicates a lake elevation of 92 ft (Bly gage) in the fall of 1875. Various other scattered observations, together with rainfall records, enable the fluctuations of the lake to be interpolated fairly adequately from 1875 to 1915, when continuous records begin. Such scattered records include the dates when water reached certain depths in adjacent cellars or lake elevations at the time a pumping plant was constructed on the lake.

The rise of the lake since 1875 has submerged and

killed many trees. Although decay has destroyed some stumps, many remain, and on these the annual rings can be counted to determine the age of the tree. During different visits to the lake since 1931, I have counted the rings on many such stumps and determined the elevation of the ground on which each tree grew. The records of lake stages since 1875 fix the year in which the trees were submerged, and the age of each tree indicates the length of time during which the water surface must have been below the elevation at which the tree grew.

Results of such tree counts for about 40 stumps are shown in Fig. 2. One of these trees grew at a much lower elevation than any others found—on land 10 ft lower than any lake stage since 1875. Other trees that may have grown at similar elevations had been washed out or decayed. The stump remaining had a strong root system well wedged in a rocky area that enabled it to resist wave action. It was partly decayed, but 80 tree rings could be counted, and a part of the thickness represented at least 20 additional rings which were indistinct.

For higher elevations the 245-year-old tree at elevation 99 is the controlling one. The number of stumps found which approach or exceed an age of 200 years indicates that Eagle Lake had not been above the stage reached in 1900 for over 200 years previously. Above the high water line of 1917 stand trees about 400 years old; the high water of 1917 was the highest in this period.

These tree records do not indicate how low the lake may have fallen; they only show that it did not rise high enough to kill the trees during the period of their growth. Old settlers around the lake report Indian accounts of their having crossed the narrows leading to the upper arm of the lake on horseback. This would require a lake elevation more than 10 ft below that of the lowest stump found. These records show that Eagle Lake has been continuously higher since 1860 than it was from

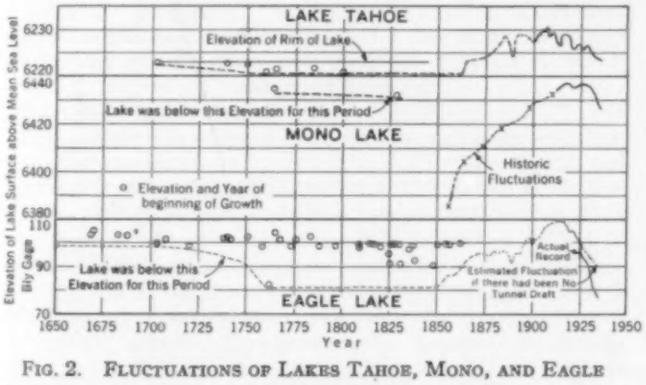


FIG. 2. FLUCTUATIONS OF LAKES TAHOE, MONO, AND EAGLE
As Indicated by Age and Location of Submerged Trees and Historic Records

1760 to 1860, and that it reached higher stages from 1895 to 1925 than it had since at least 1650, or for 250 years. Even with the tunnel draft, until 1932 the lake did not fall as low as its high water mark from 1760 to 1860, and without the tunnel draft it probably would now be higher than it was at any time between 1750 and 1860.

MONO LAKE SLIGHTLY AFFECTED BY ARTIFICIAL CHANGES

Mono Lake has been less affected by artificial changes than any other of the enclosed lakes in the western Great Basin. There are also occasional records available for it over a longer period than for other adjacent lakes. Much of its past history was presented in recent condemnation proceedings brought by the Los Angeles Bureau of Water and Power. The bibliography on this and other lakes prepared by H. B. Lynch, M. Am. Soc. C.E., for the Metropolitan Water District of Southern California was also made available to me and saved me much time in finding the sources of early records. I also did additional field work on this lake.

The first records for the lake are based on the U. S. Land Survey of 1856 and 1857. Relocation of meander corners gives somewhat variable results but indicates that the lake was at least as low as elevation 6,393 in 1857 and may have been as low as 6,386. The work of I. C. Russell in 1883 (Eighth Annual Report of the U. S. Geological Survey, 1886–1887) furnishes the basis for several comparisons of the lake then and now, such as the present submergence of roads then in use, soundings in the lake,

STUMP ONE HUNDRED YEARS OLD, ON EAGLE LAKE
On Ground Lower Than the Lake Had Been Since 1875, Until Drained by Tunnel in 1932

notes and sketches of tufa domes, and levels between the lake and Adobe Meadows Pass to the east. These comparisons indicate that the lake was from 3.5 to 7 ft lower in 1883 than in 1934. I have used a difference of 6 ft, giving the elevation in 1883 as 6,409 ft. Other scattered sources of information make it possible to fill in the general fluctuations prior to 1912, when direct records begin.

Some older tree records are also available on this lake. The climate is too arid for the general growth of trees around it, but mountain mahogany grows on parts of its western shore. Ellsworth Huntington, in the *Proceedings of the 19th International Congress of Americanists* (Washington 1915), reports a tree 150 years old killed in 1914, and I found one 83 years old killed in 1912. These trees show that the lake was higher from 1910 to 1920 than it had been at any time since about 1750. Roots and other remnants of brush and trees are visible to depths of 10 or 12 ft below the 1934 level, which is the limit of visibility. The lake has evidently been below its recent levels for periods sufficiently long for such trees to grow.

The lake shows a generally continuous rise during the period of historic record up to 1919, reaching heights greater than any for 150 years previously. Recent lowering has amounted to only about one-fourth of the total rise since 1857.

EARLY RECORDS FOR WALKER LAKE

Walker Lake, like Pyramid Lake, has been materially affected by diversion for irrigation from its tributary streams. It is only in the earlier years of record that it reflected the water supply conditions of its area. Information regarding this earlier history has been furnished by E. W. Kronquist of the U. S. Indian Service, and since 1928 records have been kept by the U. S. Navy at the Hawthorne Ammunition Depot. Walker Lake rose from 1860 to 1877 and has dropped about 70 ft since the latter date. Without irrigation its fluctuations since

1877 would probably have been similar to those of Mono Lake, because prior to 1877 it showed a similar rise.

OTHER LAKES IN THE REGION

Two other lakes in the Great Basin, Goose Lake and Honey Lake, are unimportant in this survey. Goose Lake is partly in California and partly in Oregon, at the head of the Pit River drainage area. Pioneer accounts indicate a low stage in 1848. It overflowed in 1869 and for short periods in 1881 and 1898; it has been dry since 1926. Irrigation now utilizes much of its former inflow. Honey Lake receives the run-off of Susan River and other streams; it is a remnant of Lake Lahontan, which has a wide, shallow bed. It was dry in 1859, 1863, 1889, 1903 and from 1926 to date. It reached its highest stage in 1868 and was relatively high in 1890 and 1916. Its inflow has also been reduced by irrigation. There are a number of other Great Basin lakes on which data are lacking or not applicable.

AREA FORMERLY SUBMERGED AROUND EAGLE LAKE

While not in the Great Basin and in consequence not subject to the same climatic influences, Lake Elsinore in southern California is a similar index of run-off on its drainage area. It receives the surplus run-off of the San Jacinto River. It was practically dry in 1810 and 1859; its last of several overflows was in 1916. While lower at present than at any time since 1916, it is not as low as it has been in the past. Its inflow is now limited to the run-off from larger storms, as the usual run-off is used for irrigation. While its high and low stages would not be expected to coincide in time with those of the Great Basin lakes, it has had a generally similar type of fluctuation.

CONCLUSIONS DRAWN AND EVALUATED

For the period of historic records, Fig. 1 shows a generally similar trend for all the lakes in the western part of the Great Basin. Eagle and Mono lakes have been relatively free from artificial effects, and the other lakes show similar trends for that part of their records which is free from diversion of inflow. For the lakes in Fig. 1 certain conclusions may be drawn.

For the period covered by historic records, that is, since 1840 or generally for the last 100 years, the following conclusions apply:

1. These lakes were all at relatively low stages prior to 1860.
2. They rose during the sixties and continued on a general rising trend, where free from artificial factors, until about 1915.
3. Since about 1915 they have shown a downward trend.
4. The stages reached about 1915 were higher than any since 1840.
5. The present stages are not as low as those prior to 1860 except for the lakes subject to diversion of inflow.

For the longer period since 1650, or for nearly 300 years, the tree records, principally on Eagle Lake, support the following conclusions:

1. For 100 years prior to 1850 these lakes were continuously lower than they have been at any time since 1850.
2. The high stages reached about 1915 are higher than any reached for from 250 to 300 years.

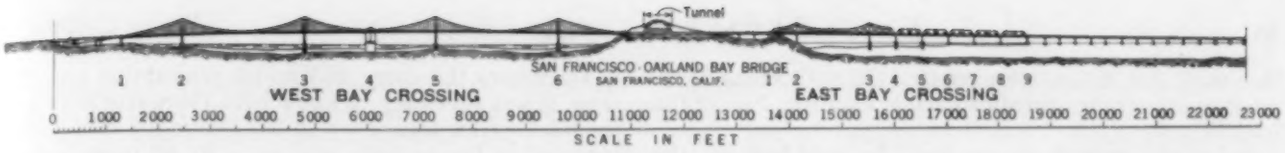
The records on Great Salt Lake alone lead to the following conclusions:

1. Great Salt Lake does not fluctuate in harmony with all the variations of the lakes in the western part of the Great Basin but does tend to follow their major movements.
2. This lake has had two nearly equal peaks since 1850, that of 1868–1878 being relatively higher in proportion to the high stage of 1915–1925 than similar stages for the lakes in the western part of the Great Basin.
3. The lake shows a lowering in recent years similar to that of the lakes to the west of it, although it did not begin until several years after they started downward.
4. It agrees with them in apparently having been continuously lower for 100 to 200 years prior to 1850 than it has been at any time since, except as affected by artificial causes.
5. These differences within the Great Basin between lakes in its western and eastern parts emphasize the caution that should be used in attempting to apply the conclusions regarding past fluctuations in the Great Basin to outside areas which are subject to different climatic influences.

While the information presented is considered to support the foregoing conclusions regarding what has happened in the past, the application of such conclusions to probable future fluctuations is a different matter. Any such applications permit a wide range of results, in which the personal factor of the forecaster can play an important part. I have been unable to find any trends or cycles in these or other climatic records from which future variations could be predicted. However, attention is called to the following points:

1. Within the last 30 to 70 years the Great Basin area has apparently experienced its most moist period of the last 300 years.
2. The last one hundred years have been continuously more moist than the preceding one hundred years.
3. The period of deficient water supply since about 1917 has not resulted in as great an accumulated deficiency as has occurred in the past.
4. The record does not support the conclusion that the climate of this area is becoming progressively drier. Although the conclusion that the climate is becoming more moist is probably not justified either, there is more indication of a tendency toward increase in moisture over the last 300 years than there is toward a decrease.
5. As many stream records were begun in this area about 1900, and in consequence include the period of maximum recent water supply following that date, caution should be used in planning water supply projects in this area based on this period. Provision should be made for meeting water requirements when the run-off is as low as it has been since about 1917, as it is to be expected that such periods will recur.

The results presented are based on material from many sources. In its collection much assistance has been furnished by many individuals. As only the general results are given, acknowledgment of all the separate items of the records used is not practicable. To the many who have assisted in securing data I wish to express my appreciation and indebtedness.



Constructing Foundations of Trans-Bay Bridge

Problems of Handling Domed Caissons and Sinking False-Bottomed Caissons to Great Depths in the Mud of San Francisco Bay

By Carlton S. Proctor

Member American Society of Civil Engineers

Moran and Proctor, Consulting Engineers, New York, N.Y.

IN an article in the December 1934 number, Mr. Proctor gave a clear conception of the problems which faced the engineers who designed the foundations for the San Francisco–Oakland Bay Bridge. Since the depth to bedrock in the West Bay Crossing—up to 250 ft below the high-tide line—precluded the use of pneumatic caissons, a cellular type with vertical cylindrical dredging wells was designed. Flotation for the caissons was provided by capping the cylinders with hemispherical domes in which the water was displaced by compressed air. In the present article, prepared from the address given by Mr. Proctor before the Metropolitan Section of the Society on October 17, 1934, the landing of these huge caissons at the pier sites is described. In their completed condition, the cells above the concrete seal are partly filled with water, the walls of the cells being sufficiently strong to resist both the vertical and the horizontal loads to be imposed on the pier.

For the piers of the East Bay Crossing, foundation conditions required a different type of caisson. Except at the first pier east of Yerba Buena Island, bedrock is too deep to be reached, and false-bottomed caissons for the cantilever spans had to be landed on gravel or sand strata, 150 to 250 ft below high-tide line. All the other piers rest on wood piles driven inside of steel sheet-pile cofferdams. By welding vertical I-beam "soldiers" to the outside of the piling, the forest of inside wales and braces usually required was eliminated, leaving a nearly clear interior for pile driving and concreting.

NOT the least of the problems that arose in connection with the foundation for the deep piers in the West Bay Crossing of the San Francisco–Oakland Bay Bridge was the protection of the caissons, during their flotation and sinking, from the risks of collision by water craft. Daily 500 ferry boats between San Francisco and Oakland and many ocean liners pass the bridge line. The hazard thus presented, especially in foggy weather, required that every precaution be taken.

The first step was to install at each caisson a temporary floating fender system of massive timber construction. A fender consisted of a raft of 12 by 12-in. and 6 by 12-in. timbers rigidly bolted together in crib formation so that its vertical cross section measured about 9 ft deep by 7 ft wide. At piers where floating working equipment was used because of the great depth to mud level, these floating fenders entirely surrounded the caisson. Where the depth permitted the construction of working docks along two sides of the caisson, the fenders closed the space between the ends of the docks, as shown in Fig. 1. Being separated from the caisson by 7 ft, the fenders not only served as a walkway but also gave considerable protection from waves. They were held in position by heavy anchors and were in no way attached to the caisson itself. The working docks consisted of large-diameter steel cylinders supported on timber piles and filled with concrete. These docks were interconnected by steel bracing, also anchored entirely independently of the caisson.

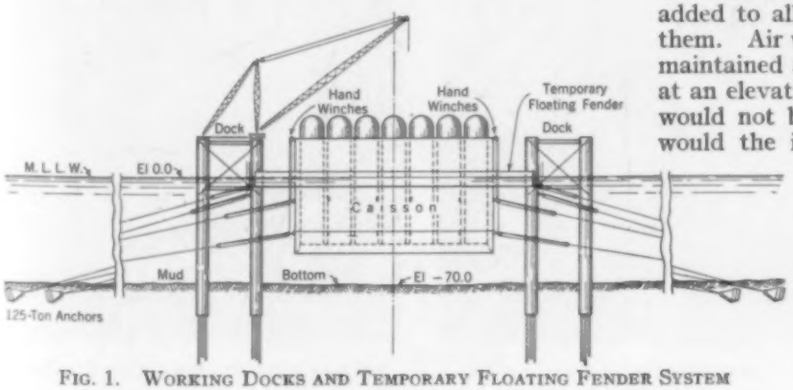


FIG. 1. WORKING DOCKS AND TEMPORARY FLOATING FENDER SYSTEM

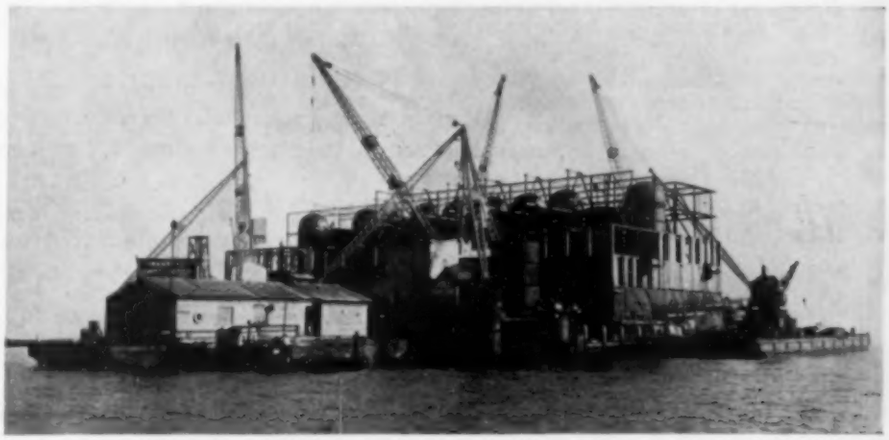
REINFORCED CONCRETE ANCHORS PROVIDED TO HOLD CAISSONS AGAINST THE TIDES

Another problem requiring careful attention was that of holding the floating caisson against the tidal current, which at this location often reaches a speed of from 5 to 7 mph. Huge pre-cast reinforced-concrete anchors were equipped with nozzles and flexible hose lines for jetting them into the bay bottom at their proper location. One of the illustrations shows the process of lowering an anchor with the cables connected for attachment to both the fenders and the caisson.

When a caisson reached the pier site, its anchor lines were attached and adjusted, additional lengths were added to all cylinders, and the domes were welded to them. Air was then pumped into all the cylinders, and maintained at the pressure required to hold the caisson at an elevation such that the side wall of the cofferdam would not be overstressed, and such that in no case would the inside water level be forced down to the cutting edge. The caisson was then concreted and the side wall of the cofferdam extended upward until the depth of submergence required extension of the cylinders. The cylinders are extended upward by burning off the domes of four of them at a time, welding on additional sections, and replacing the domes and welding them to the new sections. To facilitate

this work, the domes were constructed with skirts 24 in. long, each burning operation cutting off about 2 in. of the length.

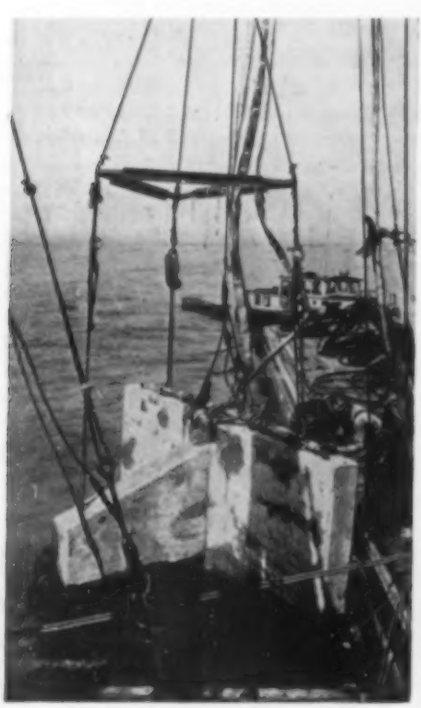
When the caisson approached the mud bottom, the concrete surface was about 12 ft below the water level. The actual grounding of a caisson required great care and delicacy of handling. The direction and amount of the tidal currents acting on the caisson were carefully measured and studied to determine the time of minimum tidal action, and the anchor lines were adjusted to allow for sag and for movement of the caisson with falling tide. Exactly at the predetermined time, the caisson was lowered to the mud bottom, while its position was constantly observed and adjustments in the anchor lines were made progressively. By the rapid release of air, the caisson was quickly lowered 2 or 3 ft into the mud. After its location had been definitely checked, it was allowed to sink 8 or 10 ft lower, to a depth sufficient to maintain its position unchanged. The anchor lines were then detached. At this time some of the domes could be removed, but some were left, so that while dredging was going on through the open wells, the remaining domes would contribute to the stability of the caisson and compensate for sloping of the mud and hard strata. In most cases the cutting edge met considerable resistance at the first hard stratum below the mud, and the dredging became more difficult. The tendency for the caisson to follow the inclination of this hard stratum was counterbalanced by the domes left in place, until the cutting edge could penetrate sufficiently to provide substantially equal support on all sides.



CONTRACTOR'S PLANT AT PIER W-4, IN WEST BAY CROSSING
Two Working Docks Supported on Steel Cylinders, with Floating Timber Fenders Connecting the Open Ends of the Docks to Protect Caisson Against Ramming. Sides of Cofferdam Are Here Being Raised

To control the entry and initial penetration into the mud, it was necessary to know both the water level and the mud level within the cylinders before the domes were removed or the air fully released. By an ingenious arrangement, these levels could be determined at any time within any cylinder. An electric cable attached to a weighted split contact point was placed in a gasketed pipe sleeve about 4 ft long. A tap removed from the top of the dome permitted entry of the device, and the gasket around the cable prevented loss of air. The cable was then fed in until the split contact point reached the water surface, which completed the circuit and thus lighted a lamp connected to the cable circuit, thereby indicating the level of the water surface. The weight was then dropped further until it met the resistance offered by the mud.

Anchor lines ran from the heavy reinforced-concrete

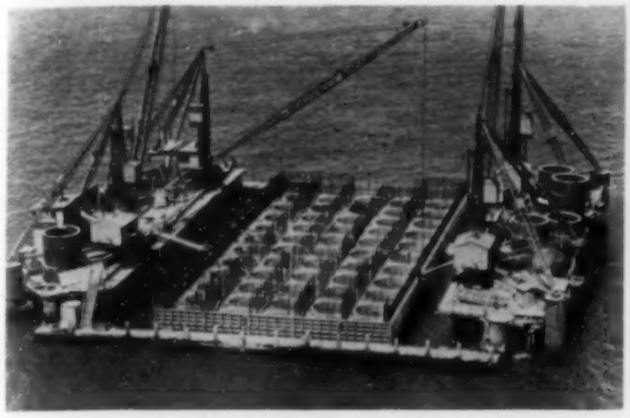


DROPPING AN ANCHOR FOR THE CAISSON AT PIER W-5

VALVES AND PIPING TO CONTROL AIR PRESSURE IN THE CYLINDERS

HAND-CRAB ATTACHMENT OF ANCHOR LINES

anchors into a connection at a high and a low level on the caisson (Fig. 1). These connections were placed at the end of the trusses in the cross walls between the cylinders. The load line was attached to hand-crabs at the top of the caisson, where cable pulls up to 125 tons could be developed. The lever-arm ratio of the hand-crab from the load line was about 100:1, and the load line led to



PIER W-4, WITH DOMES REMOVED, SEATED ON BEDROCK
Ready for Sealing with Tremie Concrete, Which Will Extend 30 Ft Above the Cutting Edge of the Caisson

a 5-sheave block providing a 10-part line to the anchor. Deflection readings were taken three times a day to determine the exact pull on each cable.

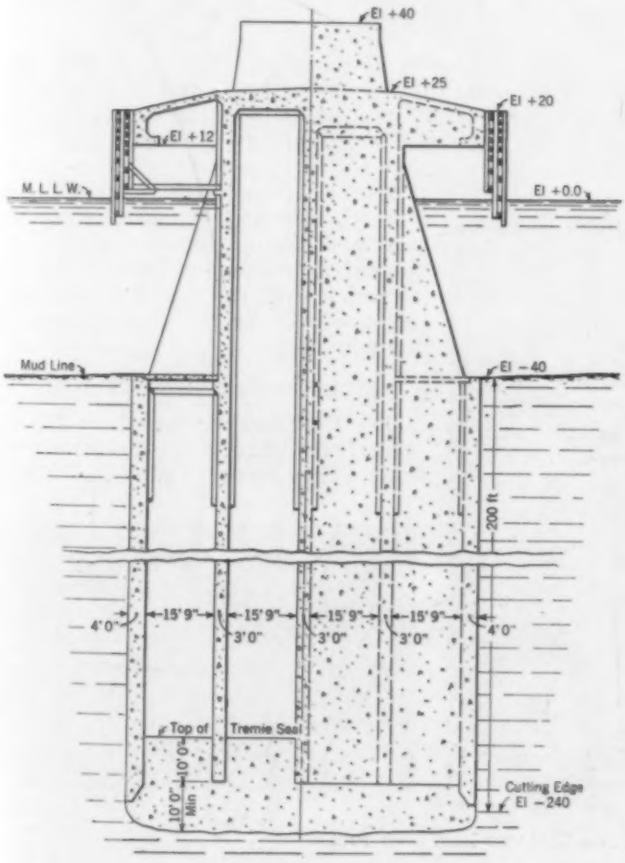
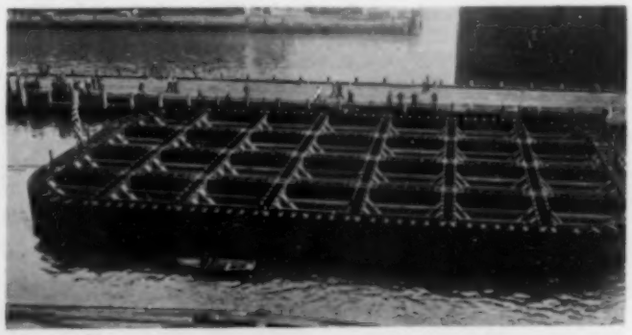


FIG. 2. CAISSON FOR PIER E-3 WITH FALSE BOTTOM SUNK 210 FT INTO THE MUD OF THE BAY BOTTOM

When the caisson was firmly supported in the mud, all the domes were removed and sinking was begun by dredging all the wells progressively. As the caisson sank, the side-wall sheeting of the caisson was raised and



FALSE-BOTTOMED CAISSON FOR PIER E-4 AFTER LAUNCHING
False Bottoms Were Pulled Out When Caisson Was Seated on Mud at About Elevation −40 Ft

additional concrete was poured. As the caisson approached rock, it was frequently necessary to jet under the cross walls. Thorough jetting of the bottom also was required before inspection of the rock floor by a diver, which in turn preceded placement of the concrete seal. An ingenious method for jetting under the cross walls was developed. A frame was constructed to support the jet by a toggle joint at the center and to fit closely into the cylinder. The back-kick of the jet pipe was resisted by the cylinder walls, while the toggle joint made possible easy manipulation and control of the jet.

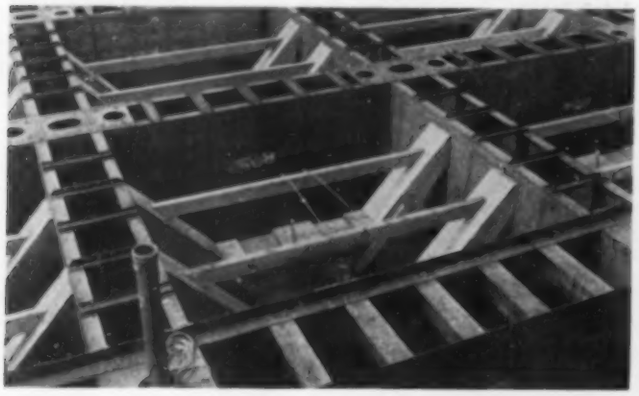
EAST BAY PIERS OF DIFFERENT TYPE

There is a radical difference in foundation design between the East Bay and the West Bay crossings. For the former, two types of foundations were required by the extreme variation in load and soil conditions at different pier locations. In the East Bay crossing the maximum loads are under the two piers supporting the long cantilever span immediately ease of Yerba Buena Island. Pier E-2, the first east of the island, is founded on rock which was easily reached by a steel sheet-piling cofferdam, but farther east the rock pitches off very rapidly. Under Pier E-3 rock is at elevation −290, but an entirely adequate foundation stratum consisting of compacted sand and gravel, continuous to rock, was found at elevation −240. It was demonstrated by consolidation tests of the underlying materials that the probable settlement of Pier E-3 would be practically negligible. At Piers E-4 and E-5, it was decided to land the caissons on a sand stratum, which would distribute the loads to the underlying softer materials to a considerable extent. The elevation of the cutting edge there was at −150.

From consolidation tests, it was demonstrated that although settlement would occur at these piers, it would not be sufficient to seriously affect the verticality of the piers or the bridge grades. All the other piers for the East Bay crossing were supported on timber piles driven deeply into the underlying strata. Since it was indicated that all the pile-supported piers might develop settlement, provisions were made to correct the grade of the bridge at a future date if required. The possibility of added settlement as a result of disturbance in the underlying clays, due to the driving of the piles, was considered. Disadvantages of the pile foundation due to any possible increase in settlement, were deemed

to be offset by its advantage under the action of lateral forces caused by earthquakes.

Foundations for piers E-3, E-4, and E-5 consisted of false-bottomed caissons. The contractors bidding on the work were given the choice of either false-bottomed caissons or sand islands for the building of these foundations, either type being suitable because of the shallowness of the water and the necessity of providing a caisson heavy enough to overcome the resistance of skin friction, particularly at Pier E-3, which had to be sunk a distance of more than 200 ft through the mud of the bay bottom.

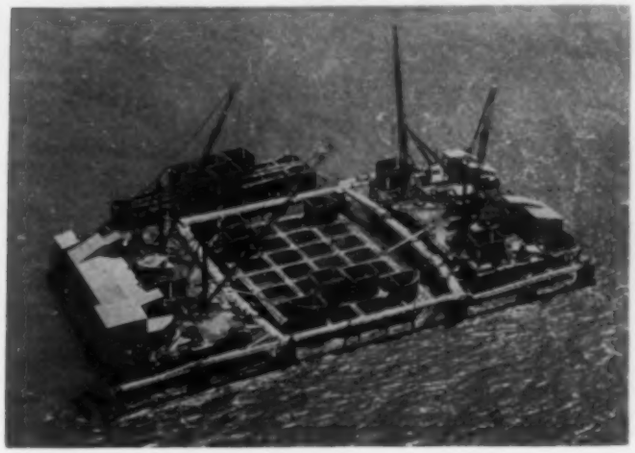


LAUNCHING THE CUTTING EDGE FOR CAISSON E-4, WITH FALSE BOTTOM IN PLACE
Detail of False Bottom and Removable "Strong-Back" Bracing

DEEP CAISSONS WITH FALSE BOTTOMS

At Piers E-3, E-4, and E-5, false bottoms for the caissons consisted of 8-in. planks supported by heavy timber cross-girders with heavy timber braces or "strong-backs." These strong-backs were separated by a specially devised toggle, which could be readily removed by grappling. The strong-backs were so set that the removal of a separator would allow them to float clear, while the false bottom with its supporting girders, thus released, would float up in sections. In the construction of the false bottoms special care was taken to provide ample clearance everywhere so as to make it easy to free them when their removal was desired. The steel cutting-edge section for the caisson at Pier E-4, floating on its false bottoms, is shown in a photograph. Another photograph pictures the false bottoms in place and braced to the walls of the cutting edge ready for the sheeting to be built up before the caisson is towed to the site.

In the East Bay caissons, the concrete was placed with concreting pumps. Each pump was served by concrete mixers, mounted on barges, which were divided into compartments for the storage of batched materials. The batches passed over belt conveyors to the mixers and from them were discharged to another belt conveyor, which in turn deposited the mixed concrete in the bins of the concreting pumps. After the concrete had been pumped into place within the caisson, it was thoroughly compacted by means of vibrating spades, which permitted the use of relatively small quantities of mixing water, thus securing a concrete of extremely high density.



PIER E-3 UNDER CONSTRUCTION
Only the Two Central Rows of Wells Were Carried Above the Mud Line

In Fig. 2 the caisson for Pier E-3 is shown in position with the cutting edge at elevation −240. Actually this caisson was dredged to elevation −242, or 248 ft below the average tide level. To reduce the pier weight and thus the intensity of the pressure on the supporting soil, these caissons were set back at elevation −40, the mud level, by placing a deck over the outside rows of dredging wells.

STEEL SHEET-PILE COFFERDAMS

For the piers supported on timber piling, steel sheet-pile cofferdams were used. They consisted of 36-in. I-beams

STEEL SHEET-PILING COFFERDAM FOR SHALLOW EAST BAY PIERS
Left, Vertical I-beam "Soldiers" on Outside to Reduce Interior Bracing. Right, Cofferdam Unwatered, Exposing Tremie Seal Which Caps the Piles; Shadows Are from Single Tier of Bracing at Top of Cofferdam. Center, Setting Reinforcing for Pier; "Elephant Trunk" Concrete Chutes in Place

welded to every fifth sheet-pile leaf. After the sheet piling had been installed, the I-beams were braced horizontally above the water surface, and the mud was excavated down to the pile cut-off level. The timber piling was then driven and cut off, and the foundation was prepared for sealing. After the tremie concrete seal had thoroughly hardened, the pier was unwatered. This method of installation has been used before, but not with the vertical I-beam "soldiers" on the outside of the cofferdam. An ideal seal was obtained by this method. As the cofferdams were pumped out, the sheeting between soldiers deflected to such an extent as to largely seal the joints, so that only a small amount of sealing material was required in them. According to this method of support, the cofferdam was braced by the tremie seal, which capped the piles at the bottom, and by a single tier of bracing at the top. Thus the usual obstructions caused by cross bracing in a deep cofferdam were eliminated.

The bridge is being built by contract under the direction of the Department of Public Works of the State of California for the California Toll Bridge Authority. For the main bridge, the Authority has issued bonds, which are being purchased by the Reconstruction Finance Corporation of the Federal Government. The building of the approaches and the maintenance of the entire bridge are to be financed from state highway funds. Construction of this $77,250,000 bridge project was begun in July 1933. By the first of December 1934, all the piers had been carried above the water line and the towers in the West Bay crossing were approaching completion. Cable spinning for the suspension spans is scheduled to start in February 1935. Steel erection in the East Bay crossing is progressing rapidly from the Oakland shore toward the end of the Key Route mole. It is expected that the bridge will be opened for traffic some time in 1937.

TWIN CONCRETE PUMP INSTALLATION FOR USE IN PIER CONSTRUCTION

PROGRESS ON EAST BAY CROSSING, DECEMBER 15, 1934
By February 1, 1935, Steel Erection Had Progressed to a Point Opposite End of Key Route Mole

River Port of Asunción, Paraguay

Problems Encountered in the Construction of a South American Port a Thousand Miles from the Sea

By A. A. Agramonte

Associate Member American Society of Civil Engineers
Constructing Engineer, Buenos Aires, Argentine Republic

As regards size or cost, the port works at Asunción, on the Paraguay River, are not outstanding when compared with other river ports accessible to ocean-going craft, but their location, over a thousand miles from the Atlantic seaboard, and the problems connected with their construction are of peculiar interest for other reasons. With an area about equal to that of Wisconsin, Minnesota, and Iowa combined, Paraguay has a population of about 800,000. Its capital city of 80,000 inhabitants is its principal port of entry and export. The history of the efforts to improve this port to handle the growing commerce of the country dates back to 1890, when a custom house and appurtenant facilities were built. The extension of these works, the subject of this article, was begun in 1927 and completed in 1934. This article has been prepared from the author's extensive report, complete with illustrations and maps covering the inception, financing, and execution of these works, which is now on file in the Engineering Societies Library. It constitutes a valuable record of engineering achievement in promoting, financing, and constructing a port project in a remote section of the globe. All engineers will find it interesting.

At Buenos Aires, Argentina, the Uruguay and Paraná rivers join to form the great tidal estuary called the river Plata. As shown in Fig. 1, this estuary, which has an average width of 40 miles, extends from the junction of the rivers nearly 200 miles to the Atlantic Ocean at Montevideo. The Uruguay River is navigable for about 200 miles above its mouth,

Bird's-Eye View of Port of Asunción in 1929
Palace at Extreme Left; Old Pier Facilities in Front of Customs House; Westward Extension Under Construction in Distance

to Salto, where rapids impede navigation except at high stages. The Paraná River, which drains over a million square miles, is navigable to Corrientes—that is, for its whole length. At Rosario the maximum flow is about 1,000,000 cu ft per sec; the minimum, 300,000; and the mean, over 550,000. A minimum channel depth of 19 ft for ocean-going vessels is maintained to Santa Fé, 375 miles above Buenos Aires, and a depth of 10 ft for the next 350 miles, to Corrientes.

At Corrientes, the Paraná River ends at the junction of the Alto Paraná River, entering from the east, and the Paraguay River, from the north. The latter is navigable for practically its entire length. Vessels drawing under 4 ft can reach Cuyabá in the highlands of the Brazilian State of Matto Grasso, a distance of 2,150 miles from the ocean. Vessels drawing 8 ft can reach Asunción at all seasons of normal years, and regular freight and passenger service is maintained between it and Buenos Aires, a distance of nearly 1,000 miles.

On the Plata River system, above Buenos Aires, the average yearly movement in shipping in registered tons is 15 millions, of which 8 millions is by sea-going vessels and 7 millions by river boats. Practically all goods for or from the zone above Santa Fé require rehandling to river craft or vice versa. This is usually done at either Buenos Aires or Montevideo. Most of the goods imported by Paraguay and a part of those exported from it pass over the wharves at Asunción.

Formation of Asunción Bay

At Asunción the Paraguay flows between soft sandstone bluffs on the east side and soft, low alluvial formations on the West. It was on the higher of these bluffs, on the east side of the river, that the city was laid out in the sixteenth century. In the seventeenth century a new channel began to form on the western or Chaco side of the river and gradually increased in size until

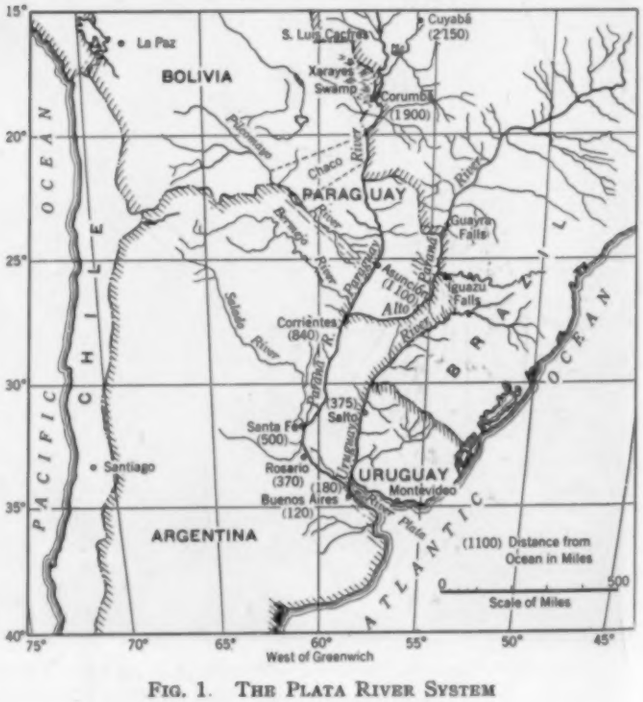


Fig. 1. The Plata River System

there were two channels with an island between them. The original channel slowly became filled with silt until finally, by the end of the nineteenth century, only a bay was left in front of the city, as shown in Fig. 2. The

In general, the plans provided for the strengthening of an existing masonry quay wall about 900 ft long, extending along the front of the existing Custom House and also for the construction of a reinforced concrete

PANORAMA OF FINISHED WORK FROM ASUNCIÓN BAY IN 1934; SECTION II ON THE LEFT, SECTION I ON THE RIGHT

small creek, Riacho Caracara, is all that now remains of the original channel. At high water the sand island is submerged and the entrance to the bay is subject to silting. However, the bay gives commodious anchorage to shipping and even at high water the current is too slow to be bothersome.

About 1895, silting at the entrance to the bay threatened to close the entrance channel. As the business of the port increased, various plans to prevent further silting were made, among them a scheme to reestablish the old main channel, now the Riacho Caracara, by placing a dam of blocks on mattresses across the new channel to divert the full flow of the river back through the old route. The cost, however, was then prohibitive to Paraguay, and in 1896 recourse was had to a steam ladder dredge with a capacity of 1,500 cu yd per day. The dredging plant proved adequate and has since maintained a satisfactory entrance channel to the bay.

DEVELOPMENT OF THE HARBOR

In early Spanish colonial days, the piers at Asunción were of timber construction. With replacements from time to time, they proved quite sufficient for the necessities of the period. About 1890 the government initiated a program of coordinated port development including the custom house offices, the warehouses and sheds along the water front, additional piers with trackage and steam unloading cranes, and extensions of the river walls. The port as thus improved may be seen in Fig. 3.

Although plans for the further extension of the shore facilities to the west (shown as dotted lines in Fig. 3) were made as early as 1910 by Dutch engineers employed by the government and work was begun in 1915 by an American corporation, the World War paralyzed the work. In 1927 the Asunción Port Concession Corporation, an organization incorporated in Delaware, presented acceptable general plans for the construction and operation of the facilities, and in 1928 contracts for the work were awarded by this corporation to an association of Buenos Aires and German contractors. The detailed plans were drawn up by the contractors, who were to assume full responsibility for the stability and resistance of their work until it should be officially accepted by the Paraguay Government.

FIG. 2. PARAGUAY RIVER IN VICINITY OF ASUNCIÓN
Port Facilities Located in the Bay

wharf on pre-cast concrete piles parallel to this quay wall and on the river side of it. This construction, referred to as Section II (Fig. 3), was to replace the five short wooden piers which extended into the river. The low ground to the west of Section II was to be filled to elevation +30.0 ft behind a quay extending for about 900 ft. A reinforced concrete wharf on pre-cast piles was to be built parallel to, and in front of this quay. Three new steel and masonry warehouses, each 82 by 217 ft, and also supported on concrete piles, were to be built in the extension. This is referred to as Section I. A complete system of tracks, water supply, electric power and light facilities, new warehouses and administration buildings, modifications of existing buildings, and traveling and fixed power cranes characterized the whole of the proposed improvement.

PILE-DRIVING EXPERIENCES

Under Section II the foundation material is a combination of sandstone and clay, locally called "tosca," the popular term for loess pampeana, a sedimentary formation characterized by great resistance and many variations as to composition. Samples cut from it here bore test loads of 20 tons per sq ft, but in place it is capable of supporting a much greater weight. The plans called for the dredging of a turning basin in front of the wharves to an elevation of 6.5 ft below mean low water, with provisions for future deepening to −10.0 ft. For this reason the piles in the front rows (Fig. 4) had to extend into the tosca a sufficient depth to provide stability when the dredging was completed. As no piles could be driven into this material, separate holes were drilled and blasted in it to receive each pile, an expensive and tedious job. After the trial of many drilling rigs for preparing the holes, a well-boring machine using 15-in. bits of the butterfly and double-wing type, and mounted on a pontoon, was found to be the most satisfactory device. When the holes were cut, the sand was washed out with a jet. The piles were then driven to refusal with a 2-ton steam hammer mounted on a pontoon. The piles behind the quay wall were to carry a relatively light load and were driven into the material overlying the tosca with a 2-ton drop hammer falling 10 ft until the penetration under a single blow was but $^1/_4$ in.

However, it was generally less than $\frac{1}{8}$ in. The pre-cast piles in general were 14 in. square and were designed to support from 40 to 70 tons each.

Under the new wharf and the three warehouses in Section I the character of the fill was such that it required an entirely different treatment. The tosca was too deep to be reached by piles of any reasonable length. Because the material above the tosca proved to be more unstable than had been anticipated, longer piles than the plans called for were required. A considerable number of 14-in. square piles 56 ft long had been cast and 300 of them had already been driven. Numerous borings and load tests on some of the driven piles convinced the engineers that these piles would have to be driven deeper to develop the required carrying power. According to the adopted curve of pile supporting power, Fig. 5, the maximum load of 55 tons on a 14-in. pile required driving until the average penetration due to the last ten blows of a 3-ton steam hammer with a stroke of 2 ft was less than $\frac{1}{4}$ in., and a load of 40 tons required that it be less than $\frac{3}{8}$ in. To obtain these penetrations, the 56-ft piles already driven were extended in place to a length of 82 ft by adding a length of reinforced concrete, and then they were restarted and driven until the required bearing was obtained.

In the softest subsoil on the whole job, the driving of a 14-in. pile 56 ft long under the projected wharf track began with a penetration of 6 ft per blow of the 3-ton steam hammer, which gradually decreased to $1\frac{1}{4}$ in. when the top of the pile reached the surface of the water. At this depth the pile was lengthened to 82 ft and the driving continued. On restarting, after many blows to break the frictional resistance, penetration began at $\frac{3}{4}$ in. per blow, gradually increased to 1 in., and reached a safe bearing capacity, as indicated by a penetration of $\frac{1}{4}$ in. per blow, at elevation −62. In a load test, the same pile supported 60 tons without permanent settlement and 80 tons with a settlement of about $\frac{1}{8}$ in. This was considered safe.

Because the available pile-driving equipment could not accommodate the 82-ft piles needed under the wharf and warehouse walls in Section I, all 750 piles were cast in the yard to a length of 56 ft. After driving to this depth, a section was added in place to each as required, and they were then redriven to the required bearing.

Driving 12-In. Disk Piles for Warehouse Floor

Redriving 14-In. Lengthened Piles

VIEWS OF CONSTRUCTION DETAILS

Under the floors of the warehouses in Section I, 12-in. pre-cast piles 46 to 59 ft long were used. To each a disk was attached or cast to transmit the pile load more rapidly to the upper strata of soil. To save time in the case of piles already driven, hardwood disks about 30 in. square were attached by heavy bolts about 22 ft above the point of the piles. On the remainder of the 12-in. piles, heavily reinforced concrete disks were added in the yard before driving. The load-penetration curve for the 12-in. disk piles is shown in Fig. 5 (*b*). A load test on a disk pile driven to −27 ft, with a final penetration of $\frac{1}{4}$ in., gave a bearing power of 50 tons. Similar piles without disks driven to about −40 ft and a final penetration of from $\frac{1}{2}$ to $\frac{3}{4}$ in., gave test loads of from 15 to 20 tons. This is indicative of the economy and increased bearing power obtained by the addition of disks to the 12-in. piles. In all, 535 disk piles were driven.

In each section the superstructure of the wharf was designed to form continuous frames in both directions, between transverse expansion joints 130 ft apart. The wharf deck supports two standard-gage tracks and tracks for traveling electric portal cranes spanning the railroad track nearest the water. Streets contiguous to the warehouses were paved with macadam, asphalt emulsion, or concrete, according to location. The whole custom house area was enclosed within an iron and steel fence, and provisions were made for lighting the buildings and plazas with current from the local electric company. Potable water was furnished from an artesian well, and water for fire service from the river. A hardwood fender system was placed to protect the front of the wharves, cast-iron bollards and sailors' ladders were provided, and a 20-ton fixed crane was built at the extreme west end of Section I. Suitable landing stages for the smaller river craft were provided under the main wharf.

A turning basin 660 ft wide, measured from the front of the wharves, was dredged within the bay to the depth of −6.0 ft for the

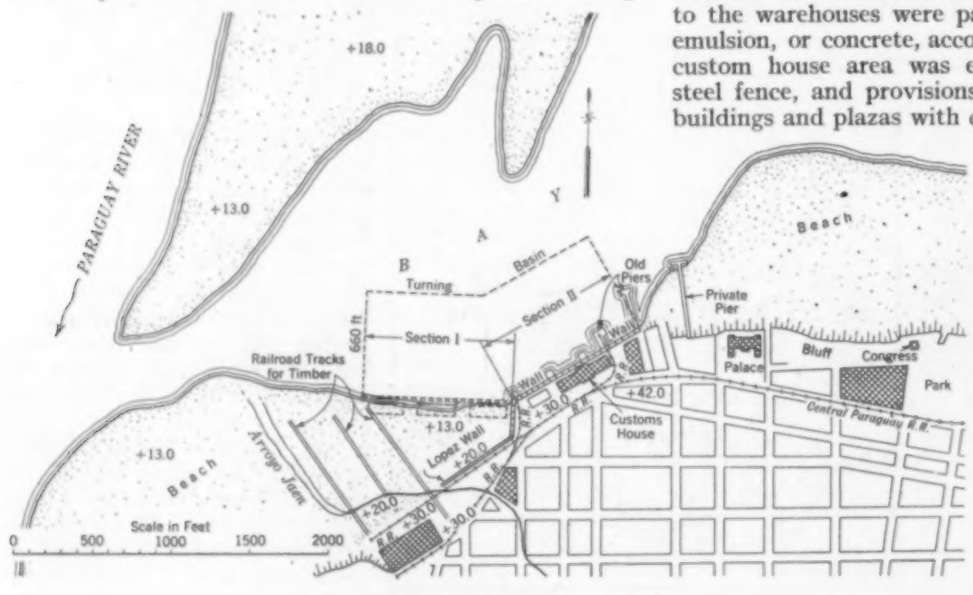


FIG. 3. PORT OF ASUNCIÓN IN 1927

Old Piers Here Shown Are in Section II. Section I Extends Westward for About 900 Ft

Normal Continuous-Frame Construction Supporting Wharf IN SECTION I AT THE PORT OF ASUNCIÓN, PARAGUAY

River Bank Protection Under Warehouse

full length of the project. As the datum is 3 ft below the lowest stage of the river, this gave 9 ft of water at that stage. The entrance channel communicating with the Paraguay River silts up so rapidly after high river levels that about 30,000 cu yd of silt is dredged out annually. The fill required for the improvement of Section I was made of material dredged from the turning basin. Spoil excavated by the government's ladder dredge, previously mentioned, was discharged to barges, rehandled by cranes to Decauville cars, and hauled to the dump. Dredging of the entrance channel was accomplished with a $1^1/_2$-yd gasoline clamshell bucket mounted on pontoons, the spoil being loaded in bottom-dump barges and dumped in the river downstream from the entrance.

CONCRETE MATERIALS

For sand, a combination of 30 per cent local fine red sand and 70 per cent crushed basalt was used. The basalt particles were from $^5/_{64}$ to $^1/_8$ in. in size and the resulting fine aggregate had a combined fineness modulus of 2.5. Crushed basalt was also used for the coarse aggregate, since local gravel did not prove quite satisfactory.

Proportions for concrete were determined by the Abrams method, and water was controlled to obtain a concrete of sufficient plasticity for proper placing, high compressive strength, and great density and resistance to water action. In the absence of a testing laboratory at Asunción, field control tests were made on small beams. For beams, slabs, and general superstructure work, a mix of 1:2.2:3.9 by volume was adopted. Although a 6-in. slump was allowed, in practice enough water was used to produce a 4-in. slump. This gave satisfactory results. For the piles the mix was richer —1:1.5:3.0 by volume, with a 4-in. slump. In some parts of the work quick-setting cement was used.

Since very little reinforced concrete work had previously been done in Paraguay, local labor had to be trained by a limited amount of skilled labor imported from Buenos Aires.

In Section I the concrete floor slabs of two of the warehouses were built before the fill had been carried up to elevation +29. Some time later the columns, walls, and roof were erected. In general the warehouse floors are carried on piles.

After the fill had been placed, it was observed that the floor in these two warehouses had settled, and investigations revealed that the fill behind the warehouses and the original ground under the fill was also settling. This settlement is attributed to the compression of the deep subsoil under the weight of the structures and the fill. The rate of settlement rapidly decreased from 1930 to the end of 1933; it totaled $^3/_4$ in. in the first warehouse and 8 in. in the second. At the third warehouse the fill was placed and allowed to settle before the floor and superstructure were built. It is of interest to note that the rate of settlement was affected by the river level and that prolonged high water even reversed the curve of settlement.

COSTS AND QUANTITIES

The total length of the wharves built is 1,840 ft; the area of warehouses, 130,000 sq ft; and the area of plazas and streets paved, 154,000 sq ft. In round numbers, United States dollars, the cost of the work may be subdivided as given in Table I.

In October 1930 the construction contract with the association of Buenos Aires and German firms was rescinded by mutual agreement. The work was continued by the Concession Corporation under my

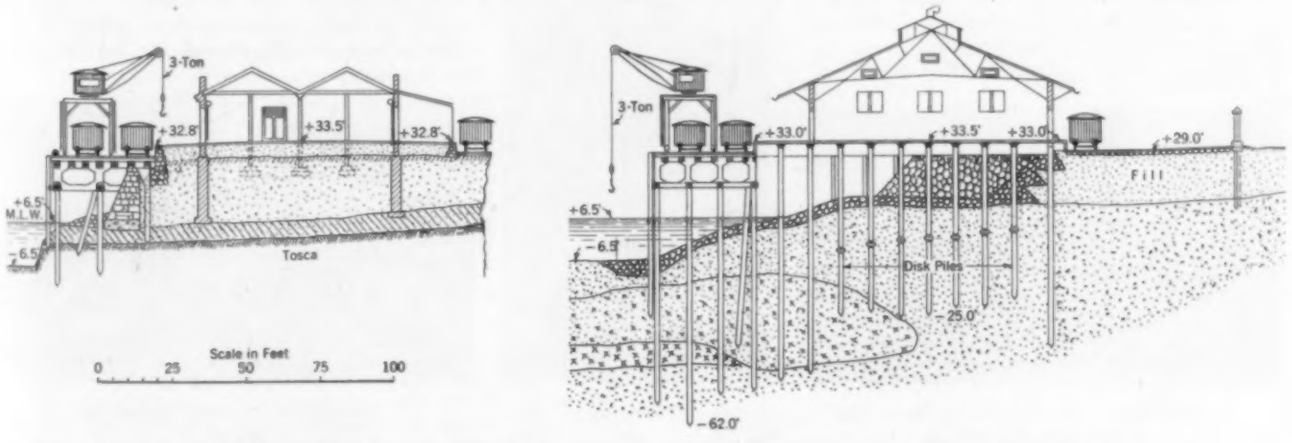


FIG. 4. (*a*) TRANSVERSE SECTION THROUGH SECTION II (*b*) TRANSVERSE SECTION THROUGH SECTION I

ADMINISTRATION BUILDING AND ONE WAREHOUSE IN SECTION I COMPLETED, 1929

direction by force account. At this time there still remained 700 lin ft of wharf to be built in Section II, including dredging and modification of existing buildings. The work was then almost a year behind the contract schedule.

TABLE I. COST OF IMPROVING THE PORT OF ASUNCIÓN

ITEM	TOTAL
Section I, including dredging	$1,062,000
Section II, including dredging	304,000
Permanent plant and equipment	289,000
Inspection, supervision, and administration	136,000
Total construction cost	$1,791,000
Financing and capitalization of the concession	1,336,000
Grand total	$3,127,000

In December 1929 part of Section I was placed in service, and the remainder was completed by September 1930; Section II was completed in August 1932 and after inspection both sections were accepted by the government. The dredging still to be done in Section II was let under a separate contract; it was retarded by high water, by breakdowns in the 20-year-old government dredge, and by the increased amount of tosca which it was found necessary to excavate in the turning basin. Half the total of 7,800 cu yd of this material had to be blasted before it could be removed. With an adequate plant this dredging job, which required two years to complete, should have been finished in eight months. The dredging contract was finally completed in March 1934.

During the execution of the work of improving the Port of Asunción, Prof. Nicolas Snarsky was Chief Engineer of Ports for Paraguay; and Agustin Muñoz and Prof. Sergio Bobrovsky were at different periods directors of public works for Paraguay. For the Asunción Port Concession Corporation, Prof. Raul Dubecq of Buenos Aires University was consulting engineer; for the general contractors, Dates and Hunt—Gruen and Bilfinger, Hans Pohl and Frederick Kruse at different periods were engineers in charge of construction; and for the dredging contractor, J. Van Haaren, Reginald Cooper, and Michael Tamusch were successively engineers in charge.

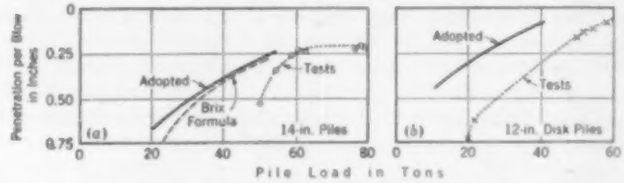


FIG. 5. LOAD-PENETRATION CURVES ADOPTED FOR PILE DRIVING
Weight of Steam Hammer and Dolly, 3.5 Tons; Stroke, 2 Ft
(*a*) For 14-In. Piles Extended and Redriven
(*b*) For 12-In. Disk Piles Extended and Redriven

During the life of the original general contract, I was chief engineer for the Concession Corporation with G. Frey and F. Fischer in charge of the staff of inspectors. After this contract was rescinded, I became Director of Works for the design and construction of the part done by force account, with Henry Pockels as superintendent of construction. From 1931 to the termination of the dredging contract in 1933, Edward Agramonte, as assistant engineer, was in full charge of the dredging contract.

Driving 12-In. Piles Into Holes Blasted in Hard Tosca Formation

Building Wharf Substructure in Front of Customs House

Looking West Along Completed Wharf

CONSTRUCTION PROGRESS IN SECTION II OF THE PORT WORKS AT ASUNCIÓN

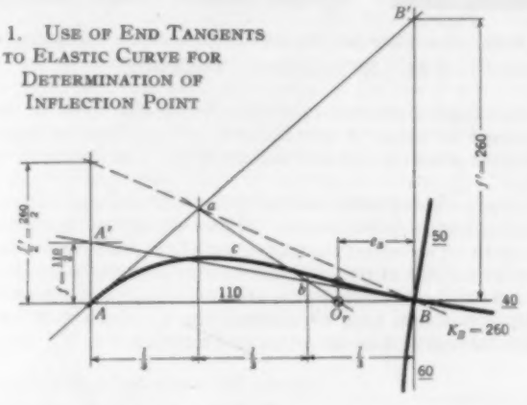
OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Graphic Location of Inflection Points

TO THE EDITOR: The simple method of locating inflection points that I outlined in the May issue as a substitute for the complicated formulas existing for the purpose, applies to beams fixed or hinged at both ends, or fixed at the far end, or any combination of these. My reason for assuming all ends fixed is that this situation comes nearest to actual conditions in continuous rigid skeleton frames. Algebraic methods, even those proposed by Messrs. Bertin and Albert in their discussions of my article, appearing in the July and October issues, respectively, are not as simple and as generally applicable as the graphical method, derived directly from visible model statics.

FIG. 1. USE OF END TANGENTS TO ELASTIC CURVE FOR DETERMINATION OF INFLECTION POINT



In the accompanying Fig. 1, which is supplemental to Fig. 1*b* in my original article in the May number, rotation of the beam AB at A by an amount equal to f'/l tends to rotate the beam at B one-half this amount. However, due to the total stiffness, K_B, at point B, the actual rotation will be only f/l, since $f = {}^1/_2 f' k_a/K_B$ in which $k_a = I_a/l_a$ for the beam AB as used by Mr. Bertin. In my example then, assuming fixed far ends, we should make $f' = BB' = 260$ and $f = AA' = 110/2 = 55$. It is seen that AB' and BA' are the end tangents of the actual elastic curve AcB, the inflection point of which is required and naturally obtained at the point O_r, where the line joining the one-third points a and b of the end tangents intersects the original straight axis, AB. Once understood, this concrete, simple relation is more easily remembered and applied without reference to textbooks, than an abstract method.

Since k equals I/l, the stiffness of a member which joins at B when far ends are fixed, its value for other conditions of support can be calculated easily as I have proved. For free far ends it is ${}^3/_4\ k$; that is, if in the accompanying Fig. 1 the top of the upper column were free, it would be necessary to make $f' = BB' = K_B = 110 + ({}^3/_4 \times 50) + 40 + 60 = 247.5$, instead of 260, and again f would equal 55. Except for this detail the method is the same.

OTTO GOTTSCHALK
Civil Engineer

Buenos Aires, Argentina
December 12, 1934

Columbia River Improvement Uneconomical

TO THE EDITOR: As Major MacDonald points out in his article on the Columbia River drainage basin, in the September issue, railway lines and highways have been extended into what was formerly almost entirely steamboat territory. This situation is not peculiar to the Columbia River basin, but has been duplicated wherever railways and highway vehicles have entered into direct competition with river steamers. The reason for this is the quicker, cheaper, and more dependable service given by land vehicles than by steamers plying on rapid waters.

A fine fleet of vessels was formerly in service on the lower reaches of the Columbia River—from Portland, Ore., downstream to Astoria and upstream to Dalles City, and thence by portage past the Grand Dalles and Celilo Falls, as far inland as Lewiston, Idaho. Practically all this river service has now disappeared, however, due to the competition of the railways and highways paralleling the river on both sides, in spite of the assistance given this traffic by the U. S. Government, in the form of the locks and canals at Cascades, and from Dalles City to above Celilo. These developments, together with minor river improvements between the mouth of the Willamette River and Pasco, Wash., have cost the Government not less than $12,000,000.

Over twenty years ago I was instructed to report to the Canadian Government on a proposal of certain interests in Alberta and British Columbia to have the Columbia River improved to permit of through navigation from the main line of the Canadian Pacific Railway to the Pacific Ocean. The purpose of this improvement would be to move the grain from the Canadian prairies by water to Portland or Astoria, at which points it would be transferred from river craft to ocean vessels. In spite of the fact that the cheapness of water transportation was used as an argument in favor of the improvement, I made an adverse report, my three principal reasons being as follows:

1. At the time of the annual transportation of grain the river has reached a low stage, and in places in British Columbia it is frozen over. This condition would necessitate holding the crop until the following year, thus preventing any opportunity to take advantage of favorable markets, and adding storage costs on the grain.

2. The project would have been uneconomical in every way, as the operating costs of moving the grain by river would have been about 20 cents per bushel higher than the rail movement to the coast, and this would have been exclusive of the cost of the necessary river improvements, which were estimated to be as follows:

River improvements in Canada	$ 5,000,000
River improvements in United States	57,000,000
Equipment required to move one-quarter of crop	3,000,000
Terminal facilities	1,750,000
Total	$66,750,000

3. The advantage of spending several million dollars of Canadian money to divert Canadian business from Canadian to United States seaports was not apparent.

In view of the passing of steamboat traffic on practically every river in the North American continent, it is rather a surprise to me to find the press and public organizations again urging river improvements to open up the Columbia for through navigation from the Canadian boundary to the sea. The old argument that "water transportation is cheaper than rail transportation" is again being used to support the movement for such improvements. Although this statement is true in certain instances when large cargoes of slow-moving goods, such as coal or iron ore, are transported over large lakes where no currents exist, the rule does not apply to general merchandise, grain, or other cargoes into the movement of which the time element enters.

J. P. FORDE
District Engineer, Department of Public Works, Canada

New Westminster, B.C.
December 30, 1934

Reinforced Hollow-Tile Lintels

TO THE EDITOR: The use of hollow tile as a material for the construction of small buildings, as suggested by Mr. Rubins, in the November issue, is worthy of serious consideration. In constructing many such buildings, especially in rural districts, the principal consideration is utility. When hollow tile is available without high transportation charges, this type of construction should compare economically very favorably with any other type. In addition, it has the advantage of fire-resistant walls, a factor of considerable importance in regions where grass fires are possible.

In cooperation with the Department of Agricultural Engineering of Oregon State College, and the Pacific Northwest Brick and Tile Association, I helped to design some standard farm buildings of hollow-tile construction. Since the majority of farm buildings are constructed by the farmer himself, simplicity of construction is of paramount importance. The most troublesome feature was found to be the door lintels, the design of which Mr. Rubins has failed to mention in his article.

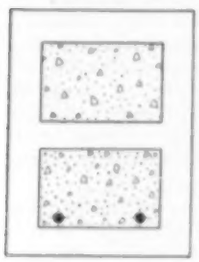


FIG. 1. HOLLOW TILE FILLED WITH REINFORCED CONCRETE FOR LINTEL

The type of lintel recommended by the tile association is fundamentally a reinforced concrete beam in which the tile acts as a form. The tiles are laid on an inclined board with the cells running longitudinally. The cells are filled with concrete, with reinforcing bars placed to carry the tensile stresses, as is shown in Fig. 1. Although this type of construction has adequate strength, it is objectionable because of its excessive weight. It must be built ahead of time so that the concrete can set, and then be hoisted into place as a unit when the walls are ready for it.

Because few farmers are equipped to hoist such a load, an attempt was made to reduce the weight of the lintel and provide one that could be constructed as needed. I developed a novel design. The accompanying photographs show the test lintel as built. The tile used was 6 by 8 by 12 in. averaging 20 lb each. Tensile stresses were carried by two $^3/_8$-in. round bars threaded through bearing plates at each end. In the test lintel the tiles were separated by pieces of wooden lath. There was no appreciable deflection when the full load was applied. The clear span was 7 ft 9 in.

THREADED TENSION RODS IN A TEST LINTEL WITHOUT CONCRETE FILLER
Clear Span 7 Ft 9 In. No Appreciable Deflection

It was proposed to lay the lintel tiles in lime-cement mortar. In order to induce initial tension in the rods by screwing down the nuts without squeezing the mortar out of the joints, it was proposed to space all tiles at both top and bottom with flat or square metal bars of the same thickness as the joints. This is essentially the familiar flat-arch type of construction, in which rods carry the thrust instead of floor beams, as in a building.

JAMES R. GRIFFITH, M. Am. Soc. C.E.
Professor of Structural Engineering
Oregon State College

Corvallis, Ore.
January 3, 1935

Advantages of the Pointed Arch

TO THE EDITOR: The article on "Art in Bridge Building" by Mr. Engel in the December issue, is of unusual interest. The pen and ink drawings, with which the author has so fittingly illustrated his paper, are an example of how in some cases an artist's handiwork can accomplish his ends better than the mechanical process of photography.

On page 628 of this article Mr. Engel speaks of the Etruscans as "an Asiatic band that besieged Rome at the time Horatius made his famous defense of the Tiber Bridge." It would be more appropriate to apply the epithet "band" to the Romans, because they were at that time insignificant as a power, while the Etruscans (who may originally have come from Lydia, as Herodotus reports) had been for centuries the great power in central Italy, and still were in 508 B.C., when Horatius Cocles, according to legend, single-handed stopped an Etruscan army under Porsenna, King of Clusium, at Pons Sublicius.

On the same page Mr. Engel says, "The Gothic arch, which followed the Roman type, is said to have been invented in Persia out of a desire to decrease the horizontal thrust on the foundations.... What this did to the arch itself was of course so damaging as to offset any incidental advantage to the foundations." I think this severe judgment of the Gothic, or pointed, arch is erroneous. In many ways it is more resistant than the semicircular arch. Consider the immense Gothic structures that were made possible by the use of the pointed instead of the semicircular arch. The failure of an arch usually is caused by the haunches giving away, which makes the top sag. A comparatively slight movement will cause a semicircular arch to collapse, while in the case of a pointed arch the haunches can yield much more before the top drops in, and collapse may be averted. This is an actual condition that I have often observed in the vaulted roofs of old Gothic cathedrals.

That the semicircular arch is not the most rational form is well known to modern engineers. In recent years several arch-viaducts have been constructed, in which the rise of the arch is greater than half the span, thus tending away from the semicircular towards the pointed arch.

R. REIMANN, M. Am. Soc. C.E.

Baltimore, Md.
January 8, 1935

Developments in Application of the Electric Analogy

TO THE EDITOR: Since the article by Messrs. Lane, Campbell, and Price on "The Flow Net and the Electric Analogy," in the October issue was written, the technique of applying the electric analogy has been extended. These developments were revealed in a study concerning the flow of water through earth dams which I have been making for the U. S. Bureau of Reclamation. The methods described are directly applicable to the analysis of earth dams and, with the proper modifications, can be utilized in the study of other hydraulic problems.

Two methods were used in studying the location of the saturation line in an earth-dam section. The first of these, which was based on a method developed in Russia, involved the use of very

thin sheets of a composition tin and lead foil as the conducting medium. The minimum thickness in which these sheets were available was 0.0005 in. Although the physical properties of the foil are nicely adapted to the cut-and-try method used in locating the saturation line, the difficulty of establishing good contact between the conductor and the electrodes makes the method somewhat uncertain. In the second method, a depth of salt solution formed the conducting material. The boundaries of the solution including the flexible upper boundary were formed with a plastic, clayey material known as plasticine.

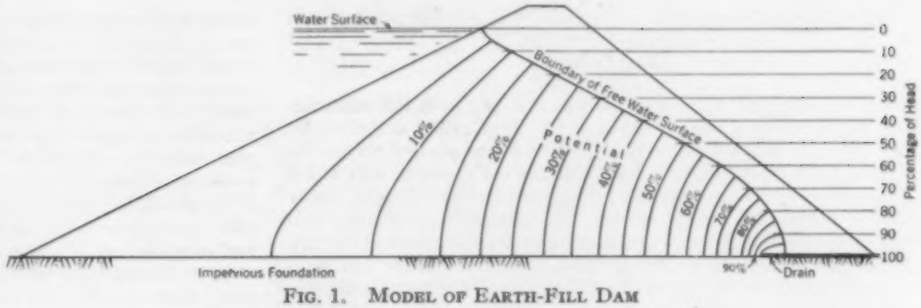


FIG. 1. MODEL OF EARTH-FILL DAM
Showing a Method of Locating Saturation Electrically

The procedure for locating the saturation line was the same in both methods. After the headwater, tailwater, and foundations had been reproduced in the electrical set-up, the unknown boundary was found by cutting and trying until it satisfied the requirements of a free-water surface. The velocity of flow in an earth dam is of such magnitude that the velocity-head may be neglected. Therefore at any point on the water surface the elevation above the datum can be taken as a measure of the potential at that point, relative to the same datum. Furthermore, the loss in potential is the same as the loss in elevation along the curve of the free-water surface. The conditions that prevail when the criterion is satisfied are illustrated in Fig. 1, which represents an earth dam with a drain at the downstream end. Any horizontal line representing the loss of head in percentage of the total head intersects the line representing the loss in potential in per cent of the total potential, having the same value, at the boundary desired.

The various degrees of perviousness encountered in the different materials comprising the dam were represented by changing the depth of salt solution in inverse ratio to the percolation coefficients. If the other dimensions remain constant, the resistance of a conductor varies inversely as the thickness. In the model the depth of the salt solution is the thickness of the conductor.

These methods are adaptable only to a two-dimensional analysis. Because many problems on flow through an earth dam cannot be reduced to a two-dimensional basis, a search has been made for a material that will permit an electric analogy in three dimensions. A material that is expected to serve the purpose has been found. This is a glue which has the property of conducting a small current when it is in the gel stage. The conductivity can be controlled, within the limits, by adding electrolytes in varying amounts.

Theoretically, the electric analogy model measurements may be used to predict quantities in the prototype. To estimate the amount of water percolating through a given earth dam, a measurement is made of the current passing through the salt solution model under a known voltage. Then the solution is siphoned into a unit container and the resistance is measured. When the percolation coefficients are known, the flow through the dam is computed by applying the ratio between model and unit resistances to the percolation coefficient multiplied by the head on the dam and the width of it.

DONALD J. HEBERT, Jun. Am. Soc. C.E.
Denver, Colo.
January 2, 1935

Effective Width of Slabs in Shear

DEAR SIR: An exceedingly valuable article on "Shear in Slabs Under Concentrated Loads" was presented in the November issue by Professor Spangler. I believe that he is correct in his statement that "There is no record of any previous attempt to study experimentally the distribution of stresses in a slab when the load is placed near one support, which is the position that produces maximum shear in the slab." Therefore the tentative empirical formula for the effective width of slabs in shear deduced from the results of these tests is the first, obtained experimentally, to be available to the designer. Professor Spangler's report, in combination with that of C. T. Morris, M. Am. Soc. C.E., of Ohio State University, on the results of tests for moment distribution (CIVIL ENGINEERING, March 1934), serves to complete the necessary specifications for the design of simply supported slabs under concentrated loads.

In these tests the concentrated loads were applied over areas varying from 1 to 4½ in. in diameter without appreciable difference in the distribution of the resulting shear. As the levers measuring the reactions were placed a minimum of 6 in. apart, the loading on these areas was in effect "point loading." It would probably have been necessary to load areas whose width parallel to the support was from 12 to 18 in., or at least greater than 6 in., in order to obtain the effect of width of loaded area on the distribution of the shear. The formula suggested for e, consequently, is that for "point loading" and should be increased by some factor of the width, parallel to the support, of the loaded area for bridge floor slabs.

The maximum unit shear in the typical bridge floor slab occurs adjacent to the longitudinal stringer. This shear in a 7-in. slab under the rear wheel of a 20-ton truck has a reasonable value, when it is computed from the formula recommended for the effective width increased by the width of contact of the tin parallel to the stringer. It appears probable, however, that this computed shear is actually somewhat excessive, for the effective width in shear of the typical, continuous slab along the 20-ft stringers, spaced 5 ft apart, should be greater than that determined from the tests on simply supported slabs whose greatest width was 7.5 ft for a 5-ft span.

C. H. GRONQUIST, Assoc. M. Am. Soc. C.E.
Robinson and Steinman, Consulting Engineers
New York, N.Y.
December 27, 1934

Manual No. 9 Corrected

TO THE EDITOR: In spite of the efforts and care of the Committee of the Construction Division which formulated Manual No. 9 on "Erection of Steel Buildings," several errors have been included. My attention has been called to a few which should be noted for the benefit of all members in their use of this publication. These appear in the paragraph entitled "Erecting a Guy Derrick," on pages 4 and 5 of the Manual.

Referring to the anchor slings for the guy derrick, the wording should read, "They should be buried about 3 ft below the finished top," instead of "3 ft above." In the paragraph at the top of page 5 two typographical errors have crept in: the drum speed should be given as 350 fpm instead of 350 rpm, and the next sentence should start with the words, "The sections of the boom," instead of "The sections of the form."

As chairman of the Committee on Manual No. 9, I am gratified to learn with what care members have studied it. The corrections noted here can easily be made by every member. I am asking that copies to be supplied in future from stock at Society Headquarters also be revised accordingly.

A. J. HAMMOND, Past-President Am. Soc. C.E.
Chicago, Ill.
December 19, 1934

Comments on Inter-Continental Highway

TO THE EDITOR: The great benefit deriving from the construction of the highway from Panama to the Rio Grande, described by Mr. James in the September issue, will be the peace and prosperity that the peoples along the route in Central America will enjoy if the project is accomplished. Lawlessness is brought under control by ease of transportation. In long-established communities of the United States, such as the mountain sections of eastern Kentucky, the construction of railways and highways has been followed by the breaking up of old feuds and of long-standing disregard of law. Much more have we a right to expect that the Indian population along the proposed highway will respond to the influences of transport in developing a desire to secure and to use the products of our machine age. This population is now without enterprise and without contact with adjoining peoples. The construction of such a highway would mean that Americans would travel over it, with the resulting contacts.

On the other hand, the highway cannot become a commercial agency of transport because the moving of goods by highway for distances of any material length will always be more costly than transportation by railroad or by sea. So no economic justification can be found for spending the large sums required for the construction of the highway in the interest of transporting goods from the manufacturing centers of the United States. The commerce over the highway will be merely that of local distribution from warehouses in the cities and towns that have rail and water transport facilities. However, the sense of security resulting from stability of government and regard for law directly due to the development of such a facility for transportation will result in effort on the part of the people along the route to accumulate goods and to trade.

As to the type of construction, it should be of the most permanent character, and not inferior to the best highway construction now accomplished in the United States. The peoples and governments in Central America will not be inclined to spend money on highway maintenance, and such maintenance needs must be kept to a minimum by the construction of permanent roadway, paving, and structures.

J. E. WILLOUGHBY, M. Am. Soc. C.E.
Chief Engineer, Atlantic Coast Line Railroad Company
Wilmington, N.C.
January 8, 1935

Placing of Concrete by Vibratory Methods

TO THE EDITOR: A brief account of one of the early, if not the earliest, successful attempts to apply vibration to the placement of concrete in a complete and orderly way may be of interest to your readers. In the design and building of two 500-ton reinforced concrete barges in Seattle in 1918, I found that the problem of the compact and homogeneous placement of concrete in extremely thin walls, obstructed by a relatively dense tangle of reinforcing bars, was acute. Designing in concrete against the stresses of a loaded ship in a seaway, or in possible beaching, is not simple, especially when the designer is faced with the necessity of providing extreme lightness to enable transportation of the largest possible pay load. Shear becomes the determining factor in practically all sections, so that a relatively high percentage of steel results. Producing concrete for long-life service in sea water, combined with the necessity for water-tightness, demanded the utmost in compactness.

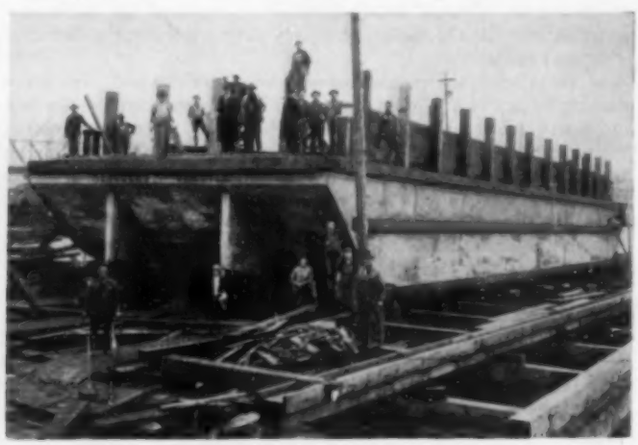
Investigation showed some high authorities to be dubious of vibration, fearing the break-up of initial set immediately behind the fresh face of the pour, especially in a continuous pour, as slow and painstaking as this one. I made a number of tests on cylinders and panels for strength and for permeability, with the cooperation and testing equipment of the city engineer's office in Seattle. After the standard mix was determined, extreme tests were made by placing cylinders immediately in the steel housing of a motor, which ran 24 hr per day. There they set and cured for 7 and 28 days under continuous and heavy vibration. These cylinders broke far above the strength of their companion check cylinders, which had been rodded and cured under standard conditions. All the vibrated samples showed much higher strength than the check samples—the average being more than double—and correspondingly high density.

I therefore equipped the ways with air lines and used eight light chipping hammers in placing the concrete. These were applied to the outside of the forms and to the reinforcing rods just above the fresh concrete. When stripped the concrete was practically free of voids and pockets. The vessels when launched and placed under load showed practically no leakage. These barges, loaded 12 ft deep, with waves washing over their decks in rough weather, and often aground, have withstood severe conditions, and after 15 years are still in service on Puget Sound. A recent letter from a competent concrete engineer states:

"You will be pleased to learn that I had occasion very recently to examine the barge which now, at least, bears the name of *Hercules*, and it is in practically perfect condition. There have been a number of very fine cracks developed in the sides but these have caused no rusting of the reinforcement or other trouble. Only at one spot on the stern did I see any sign of rust which could possibly be attributed to the embedded reinforcement."

I am aware that many men were doubtless thinking and experimenting with concrete placement by vibration in 1918, but do not know of any case where it had been applied to the extent described here.

W. C. MULDROW, Assoc. M. Am. Soc. C.E.
Engineer-Manager, Sunnyside Irrigation District
Benton City, Wash.
January 3, 1935



500-TON CONCRETE BARGE "HERCULES" BUILT IN 1918
Barge Is Still in Good Condition. Figures in Foreground Show Size of Barge

Design of Reinforced Concrete Beams

TO THE EDITOR: In the article by Mr. Mitchell entitled, "Concrete Design for Bending and Direct Stress," in the October number, there is a fundamental error in the development of some of the formulas. As the same error occurs in a textbook on reinforced concrete, attention is here called to it. This error consists in omitting the effect of direct thrust on the cross section of any beam subject to both bending and direct stresses, which results in design sections that are too small.

An inspection of Mr. Mitchell's fundamental equations will disclose no term which includes direct compression on the cross section, the thrust, N, being used only in the term for moment Ne_1. In a correct development of these equations, N must be considered as resisted by the compression area of the cross section, and this effect must be added to that due to bending. Failure to so add it leads to substantial errors in design. The equations here developed follow the correct principle, but in the nomenclature W is substituted for N, and M is used for Ne_1, since the moment is not always derived from the thrust. With these exceptions standard notation is followed.

For a design without compression steel, the development is as follows. The total compressive stress, C, in a beam at any cross section is: $C = W + A_s f_s$. At any cross section under flexure the total compressive stress, C, is on the compression side of the neutral axis, and

$W + A_s f_s = {}^1/_2 f_c kbd$, which is a general equation. Substituting $\dfrac{M}{d\left(1 - \dfrac{k}{3}\right)}$ for $A_s f_s$ gives

$$W + \frac{M}{d\left(1 - \frac{k}{3}\right)} = {}^1/_2 f_c kbd \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad [1]$$

whence

$$k^2 - 2k\left(\frac{W}{f_c bd} + 1.5\right) + \frac{W + \frac{M}{d}}{{}^1/_6 f_c bd} = 0 \ldots\ldots \quad [2]$$

With b, d, and f_c assumed, k may be found, and then f_s, from the equation, $f_s = f_c n\left(\dfrac{1}{k} - 1\right)$. If this does not give an excessive value of f_s, then A_s may be found from the equation, $A_s = \dfrac{M}{f_s d\left(1 - \dfrac{k}{3}\right)}$.

If f_s is found to have a greater value than is allowable, the value of d or f_c used is in error.

If b, f_c, and f_s are assumed, then the correct value of d may be computed by Equation 1 transformed to

$$d^2 - 2d\frac{W}{f_c kb} - \frac{2M}{f_c kb\left(1 - \frac{k}{3}\right)} = 0 \quad \ldots\ldots\ldots \quad [3]$$

The assumed values of b and f_c are then substituted as well as the value of k corresponding to the assumed values of f_c and f_s. The value of A_s may be found from the equation,

$$A_s = \frac{M}{f_s d\left(1 - \frac{k}{3}\right)}.$$

The value of d thus found can be reduced by using compression steel or a larger amount of tension steel, or both. A larger amount of tension steel tends to reduce the value of f_s and reduction in the compression steel tends to increase it, with the result that d may be reduced in value substantially without much change in the amount of tension steel required, if a proper amount of compression steel is used.

For designing with compression steel, the method is as follows. The total compressive stress, C, in the beam at any cross section is,

$$C = W + A_s f_s$$

At any cross section under flexure the total compressive stress, C, is on the compression side of the neutral axis, and

$$W + A_s f_s = {}^1/_2 f_c kbd + (n - 1) A'_s f_c \frac{kd - z}{kd}$$

For most cases a value of z equal to $0.3\,kd$ may be used to find the value of k without appreciable error.

Substituting this value of z and the value of $A_s f_s$ from the equation, $A_s f_s = \dfrac{M}{d\left(1 - \dfrac{z}{d}\right)}$ gives

$$W + \frac{M}{d(1 - 0.3k)} = 0.5 f_c kbd + 0.7 (n - 1) A'_s f_c$$

If the values of A'_s, b, d, d', f_c, and n are assumed, then A_s may be computed. From the last equation, k is first found, and then f_s from the equation $f_s = f_c n\left(\dfrac{1}{k} - 1\right)$. If f_s is not excessive, then A_s may be found from the equation

$$A_s = \frac{M}{f_s d\left(1 - \frac{z}{d}\right)}$$

in which $\dfrac{z}{d} = \dfrac{k}{3} - \dfrac{\frac{k}{3} - \frac{d'}{d}}{1 + \frac{bkd}{2(n-1)A'_s}}$

If the resulting value of f_s is excessive, then either A'_s or d or both may be reduced, or a value may be assumed for k of not less than that ordinarily determined by assumed values of f_c and f_s, where compression steel is not used.

HARRY E. ECKLES, M. Am. Soc. C.E.

Chicago, Ill.
January 7, 1935

Analysis of Horizontal Earth Pressure

TO THE EDITOR: In his article in the December issue Mr. Meem has given a practical analysis of the horizontal earth pressure of retained vertical embankments. His analysis is undoubtedly correct. Paradoxically, the partial fluid static pressure distribution assumed by the Rankine theory, may also be demonstrated. The seeming conflict can be reconciled when it is understood that both theories are based on partial truth.

The disconcerting variable is the factor of horizontal earth displacement. The Meem and partial fluid static theories represent extreme cases of an indeterminate problem. According to Mr. Meem's method, a large distortion of the earth occurs concurrently with high internal strains. In the partial fluid static condition, no displacement should be assumed and no internal strains will exist. Partial and localized restraints of earth displacement may produce an infinite number of pressure distribution patterns. In practice, therefore, the pressure distribution will be determined by the character of the retention.

In temporary structures and in the interest of economy, earth distortion, with its accompanying internal stress, should be allowed to develop to its allowable maximum. This is accomplished by Mr. Meem's method.

L. C. WILCOXEN, Assoc. M. Am. Soc. C.E.
Assistant Civil Engineer, City Engineer's Office

Detroit, Mich.
December 24, 1934

Resistance of Concrete Slabs to Concentrated Loads Near Support

TO THE EDITOR: In connection with Professor Spangler's article in the November issue, it may be of interest to note the results of German tests on the resistance of concrete slabs to concentrated loads applied near a support. The tests were reported in 1933 by O. Graf in the *Deutscher Ausschuss für Eisenbeton*, Heft 73.

Three reinforced concrete slabs were tested to destruction with concentrated loads applied through rectangular steel plates, 10 cm by 15 cm, placed with the long side parallel to the supports and at varying distances from them. One side of each slab was freely supported, and the other side was made continuous with a concrete beam to provide restraint. In Table I are given the principal dimensions and the strength of concrete used in the test slabs as well as the magnitude of the concentrated load at failure.

The results of these tests were summarized by Mr. Graf substantially as follows.

1. In all cases, the concentrated load punched an inverted funnel-shaped hole through the slab, with inclined planes of failure making angles of about 30 deg with the horizontal, except on the side adjacent to the support where failure occurred on a plane of greater inclination extending from the edge of the loaded area to the edge of the support.

2. The ultimate load increased as the point of application approached the support and was greater at the restrained support than at the free support.

3. The ultimate load increased with an increase in concrete strength, but the increase in ultimate load was relatively smaller than the increase in the cube strength of the concrete.

4. The ultimate load did not increase in proportion to the tensile strength of the concrete as determined from bending tests of plain concrete beams.

5. The ultimate load did not increase in proportion to the shearing strength of the concrete.

6. Initial cracks appeared at higher loads in the slabs with concrete of higher strength, but the difference between the loads causing such cracks was much smaller than would be expected from the difference in concrete strengths.

7. If the effective width of slab is taken as five times the slab thickness and a working stress in shear of 6 kg per sq cm is used, a factor of safety of at least 4 is provided.

Making allowance for the difference between cube strength and standard cylinder strength, the quantity 6 kg per sq cm is approximately 6 per cent of the ultimate strength of the weakest concrete used in these tests.

It is concluded from the third, fourth, and fifth results that the resistance of slabs to concentrated loads cannot be predicted from the compressive, tensile, or shearing strength of the concrete. It may be noted that Professor Spangler's tests indicate an increase in the intensity of shearing stress as the load approaches a support and that the German tests show an increase in shear resistance as the load approaches a support. The latter, undoubtedly, is due to the fact that within a region near the support a portion of the resistance changes gradually from diagonal tension to punching shear.

EUGENE MIRABELLI, M. Am. Soc. C.E.
Assistant Professor of Structural Engineering, Massachusetts Institute of Technology
Cambridge, Mass.
January 6, 1935

TABLE I. PRINCIPAL DIMENSIONS AND STRENGTH OF CONCRETE USED IN TEST SLABS

Slab Number	Span (m)	Thickness (cm)	Concrete Strength (kg per sq cm)			Ultimate Concentrated Loads (kg)			
						Restrained End		Free End	
			Compression (Cube)	Shear (Punching)	Tension (Bending)	*e = 5 cm	e = 10 cm	e = 10 cm	e = 15 cm
1243	2.0	14	195	44	28	....	24,000	21,000	.....
1244	1.4	12	136	31	21	28,000	20,000	16,000	15,000
1245	1.4	12	241	69	43	34,000	26,200	20,000	21,000

*e = distance from edge of loaded area to edge of support.

Rôle of Architect in Engineering Design

DEAR SIR: The article on "Art in Bridge Building" by Mr. Engel, in the December issue, is very interesting. However, while I believe this article to be useful in calling attention to the need for considering architectural requirements in the design of bridges, I do not agree either with the author's statement of principles or with his conclusions. He says: "It is hoped that the evidence to be submitted will stress the essential truth of this conclusion that the best appearing bridge is always the one in which the engineering solution is correct, the architectural treatment serving merely to emphasize the important features of the design."

It can easily be shown that this line of reasoning is fallacious, if consideration is given to the fact that, in the design of most important bridges, several "correct" engineering solutions differing materially in appearance are possible, and that the design selected is nearly always the one which is found to be the most economical and not necessarily or usually the one that is most beautiful. In substance, this statement is often used by engineers to justify the ugly structures that usually result when the engineer fails to collaborate with the architect in the design of a structure.

I hold just the opposite view from Mr. Engel's. Before the Association of State Highway Officials, held in Atlantic City in February 1928, I expressed myself on the subject as follows: "It is not sufficient, as many engineers seem to think, to turn over a completed structural design to an architect to 'doll up.' The lines of a structure are of much more importance than the ornamentation. The architect ought to be in on the design from the outset."

Some of the bridges illustrated in Mr. Engel's article are without doubt beautiful structures, but I am sure that many will differ with him on the subject of others, notably the Quebec Bridge. It should also be noted that architects were employed on several of the bridges mentioned, or illustrated, and their influence undoubtedly has added to the attractiveness of the structures in question. Examples of these are the Brooklyn Bridge, which is, in my opinion, still the most beautiful of suspension bridges; the George Washington Bridge; and, as far as can be judged from appearances, the Pont Adolphe.

The fact is that while the sheer monumental character of great spans often lends them a kind of beauty, which architectural treatment can scarcely enhance, the same consideration does not apply in the case of the vast majority of lesser structures designed by the engineer alone. It is in this field that the assistance of the architect is most needed. Again, there are engineers who have had no architectural training but who, having an eye for line and symmetry, turn out satisfactory structures. Other engineers, sometimes by accident, do design structures that may be considered beautiful. But this, in my opinion, is neither a reason nor an argument for not employing an architect on most, if not all, public structures.

Mr. Engel states that "dictation on the part of the architect in bridge design is out of place," and decries the work of art commissions in engineering design. I believe that this sentiment is reactionary. The need in this country is not for less dictation from art commissions but for more, providing of course that these commissions are competent. If engineers had such advice, they would in many cases be prevented from foisting on a long enduring public the ugly structures that now deface the landscape and will continue to do so until they wear out or are torn down.

L. G. HOLLERAN, M. Am. Soc. C.E.
New York, N.Y.
January 9, 1935

SOCIETY AFFAIRS

Official and Semi-Official

Arthur S. Tuttle, the New President

IN ENGINEERING AS in other walks of life it is recognized as a truism that if you want a strenuous job capably filled, you must look for a busy man to tackle it. Perhaps it was on this basis that Arthur Smith Tuttle was chosen for one of the most exacting years of work demanded by any engineer, that of President of the Society for 1935. His background, his character, his experience in its every detail, are guarantees that the task will be capably handled.

His progress to the zenith of his profession has been continuous and sure. Born in central Connecticut, on March 26, 1865, he matriculated at New York University, from which he was graduated in engineering in 1885. That he was not afraid of hard work even in those days is evident by his election to Phi Beta Kappa. Starting immediately to work for the City of New York, he remained almost continuously in its employ for the succeeding 48 years. One break in this long connection occurred early in the new century, when he spent a year on investigation work concerned with irrigation and water power in Hawaii.

On his return from Hawaii in 1902, he entered the service of the Board of Estimate and Apportionment of the City of New York, where he was to find a fertile field for his abilities during the remainder of the period of his service to the city. This board has executive control of the entire metropolis, and its engineering problems are many and difficult. They therefore provided ample opportunity for Arthur Tuttle to demonstrate his outstanding professional activities and characteristics—the limitless capacity for hard work and the thoroughness in detail which he exhibits when he undertakes the analysis of any problem presented to him for solution. With these characteristics, plus a most pleasing personality, he progressed successively through the grades of assistant engineer, deputy chief engineer, chief engineer, and consulting engineer for the board. As this service constituted the bulk of his life's work, it is not amiss to note the extent and variety of his duties. These included city planning, with zoning, street improvement, and grade crossing elimination; sanitary projects, involving sewers, sewage treatment plants, and sewage disposal, including the notable Ward's Island Sewage Treatment Works; the West Side improvement of the New York Central Railroad, an extensive and important element in traffic relief; the important city approach to the George Washington Bridge; and many other vital features essential to the growth of a vast metropolis.

Possessed with a rare talent for diplomacy, Mr. Tuttle found many uses for this quality in his city work. Many of the negotiations were trying and anyone else might well have given up in despair. But he was never hasty in his decisions, tending rather toward a judicial attitude, giving due weight to all sides of a question. Thus his work with the Board of Estimate and Apportionment was an outstanding success.

ARTHUR SMITH TUTTLE
President American Society of Civil Engineers

Such honor and advancement would seem to have given ample excuse for a breathing space in an active life. But not with a man whose work may be said to be his hobby. And so, despite an ostensible retirement from active practice in March 1933, as a matter of fact since that time he has pursued an even more energetic life than before. A number of worth while endeavors immediately engaged his attention, notably as a member of the New York City Emergency Work and Relief Administration, and as consulting engineer for the Citizens' Budget Commission of the city. Starting in August 1933, he has continuously served as New York State Engineer for the Federal Emergency Administration of Public Works; and as if this were not enough, he has likewise represented the Government as project engineer on the important Triborough Bridge, now being built to connect the boroughs of Manhattan, the Bronx, and Queens.

With all these activities, he has not been willing to leave his share of professional organization work to others. If space permitted inclusion of a list of all the important positions he has filled—in the Society and affiliated organizations, in other engineering societies both local and national, in alumni work at New York University, and in a variety of social organizations—readers would find it hard to believe that one person could have held them all.

Many members and officers of the Society will have the privilege of working in close contact with Mr. Tuttle during the coming year. What sort of person will he prove to be? They will find in him two dominant characteristics—keen concentration and prompt action. He is able to grasp the details as well as the larger aspects of his problem, and to him the essentials, whether the weak or the strong points of a proposal, are immediately patent. And so any proposition which he has considered, analyzed, and approved, will seldom prove to be faulty. Added to this enjoyment of detail, which seems to appeal to him more than to most engineers at the peak of their profession, he combines a driving force which cannot but arouse admiration, since he always carries his full share of the work. The celerity and decision with which Mr. Tuttle acts is aptly illustrated by the speed with which he organized a force to be put to work on the contract of the Narrows tunnel, proposed between Brooklyn and Staten Island, within 11 months after his assignment to the position of chief engineer on that project, in addition to his other work with the Board of Estimate and Apportionment.

It sounds almost incongruous to state that such a storehouse of energy is governed by a temperament that is calm—which does not mean cold. He is seldom ruffled or worried under the stress of circumstances or by any unforeseen turn of events. Furthermore, expediency has never played an important part in his solution of difficult problems. A "yes man" has never attained a prominent place in his organization, and a characteristic fully appreciated by his associates is that a sincere and honest argument has no unpleasant aftermath.

Those members of the Society who are privileged to enjoy social contacts with Mr. Tuttle will indeed be fortunate. He will be found genial, fond of a good joke, possessing the saving grace of a fine sense of humor. He has a zest for the lighter side of life when opportunity offers, and his inherent enthusiasm for the occupation of the moment makes him "the life of the party" in social gatherings. In his long and notable career as an engineer and in his contacts outside the profession, he has accumulated a host of loyal friends, both in his home city and throughout the nation. As is evident from the list of his activities, he is generous of his time and energy in good causes. Many a young engineer in need of a push up the ladder has found him ready to lend a helping hand.

He plays as hard as as he works. When he turned his mind toward retirement he took up golf. But since even friendship does not hold beyond a certain point where golf is concerned, his friends insist that as a golfer he remains an outstanding engineer.

Office hours are never sufficiently long to permit Mr. Tuttle to accomplish the tasks he has assigned himself, with the result that few are the nights when his desk at home is not in use. That this has not adversely affected his health and disposition may be partly due to his habit of reading a chapter of a detective story before retiring, thus banishing completely the cares of the day.

In the hands of such a man the directive force of a great engineering society can be left with the utmost confidence. His past performances during a long career are guarantee that he will be efficient and conscientious in his loyalty to a great trust. The Society may therefore rest assured that in Arthur S. Tuttle it has chosen for President in 1935 a great engineer, a civic-minded citizen, and a warm-hearted gentleman.

Secretary's Abstract of Executive Committee Meeting

ON DECEMBER 21, 1934, the Executive Committee met at Society Headquarters with President Harrison P. Eddy in the chair. Present were: George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Hogan and Hammond. The incoming President, Arthur S. Tuttle, was present by invitation.

Approval of Minutes

The minutes of the meeting of the Executive Committee held on October 1, 1934, were approved.

Code of Ethics: Ballot on Amendment Adding Paragraph 7 Carried

The report of the tellers was reviewed in connection with the canvass of the ballot on an amendment to the Code of Ethics of the Society, the canvass having been made at Society Headquarters on December 14, 1934.

To the present code, which begins, "It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the American Society of Civil Engineers": the vote was favorable to adding the following seventh paragraph: "To use the advantages of a salaried position to compete unfairly with other engineers."

The President ruled that the seventh paragraph is now a part of the Society's Code of Ethics.

Waterway Clearances

The Executive Committee adopted the following statement of principle with respect to waterway clearances, as drafted by the Western Society of Engineers:

"That proper clearances for structures over navigable streams are those which will not unduly interfere with the operation of either land or water transportation, place burdensome restrictions on their future expansion, or cause unwise expenditures to be made for physical readjustments. There should be a balance in the

1934 BOARD OF DIRECTION OF THE SOCIETY

The 1934 Board of Direction finished its business at the session held on January 15, 1935, just prior to the Annual Meeting in New York, N.Y., and turned over its unfinished business to the new Board, which held its first meeting shortly thereafter. Beginning at the nearest corner of the table, and proceeding around it in a clockwise direction, those present at the final session of the meeting of the 1934 Board of Direction were, as photographed here: Edward P. Lupfer, Director, District 3; B. A. Etcheverry, Director, District 13; E. B. Black, Director, District 16; Henry D. Dewell, Vice-President, Zone IV; J. C. Stevens, Director, District 12; C. E. Trout, Director, District 1; James F. Sanborn, Director, District 1; Frederick H. McDonald, Director, District 10; Thomas J. Wilkerson, Director, District 6; Henry J. Sherman, Director, District 4; John H. Gregory, Director, District 5; Ralph J. Reed, Director, District 11; J. P. H. Perry, Director, District 1; W. W. Horner, Director, District 14; Frank G. Jonah, Vice-President, Zone III; Henry E. Riggs, Director, District 7; F. A. Barbour, Director, District 2; O. H. Ammann, Director, District 1; Edward N. Noyes, Director, District 15; Robert Hoffmann, Director, District 9; Otis E. Hovey, Treasurer; Carolina Crook, Secretary to Mr. Seabury; George T. Seabury, Secretary; Harrison P. Eddy, President, 1934; John P. Hogan, Vice-President, Zone I; M. L. Enger, Director, District 8; and Alonzo J. Hammond, Past-President. Absent: Frank O. Dufour, Vice-President, Zone II; and Herbert S. Crocker, Past-President.

economic and other public interests of both forms of transportation."

Engineers' Council for Professional Development

Approval was given to the proposal that the Engineers' Council for Professional Development be authorized to proceed with the accrediting of the curricula of engineering schools.

Proposed Budget for 1935

The Society's budget for 1935 was drafted for presentation to the Board of Direction at its meeting in January, and other routine matters of Society business were considered and acted upon.

Meeting of the Outgoing Board of Direction—Secretary's Abstract

ON JANUARY 14 and 15, 1935, the Board of Direction met at Society Headquarters with President Harrison P. Eddy in the chair; and present, George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Ammann, Barbour, Black, Dewell, Enger, Etcheverry, Gregory, Hammond, Hoffman, Hogan, Horner, Jonah, Lupfer, McDonald, Noyes, Perry, Reed, Riggs, Sanborn, Sherman, Stevens, Trout, and Wilkerson. The members of the incoming Board were also present by invitation.

Approval of Report and Minutes

The Board issued its Annual Report; it also approved the minutes of the Board of Direction meeting held on October 1 and 2, 1934; also the minutes of the Executive Committee meeting held on December 21, 1934.

By-Laws of United Engineering Trustees, Inc.

In approving the minutes of the meeting of the Executive Committee held on December 21, the Board sanctioned the revision of the by-laws of United Engineering Trustees, Inc. In general, this revision changed the stipulated 9-trustee vote, which has been a requisite on certain matters, to a three-fourths vote on matters of major import, thus making practicable, without further revision of the by-laws, the admission of another or even more than one additional Founder Society. Other changes make it practicable for the United Engineering Trustees, Inc., to be somewhat more flexible in taking action on matters of relative unimportance, at the same time retaining the general principle that no action of importance may be taken without the approval of representatives of all the societies concerned.

Changes of Society By-Laws

Article V, Section 6 (*a*) of the Society's By-Laws was changed so as to entitle each Student Chapter to a copy of each issue of both PROCEEDINGS and CIVIL ENGINEERING.

Constitutions of Local Sections

Approval was given to slight changes in the constitutions of the South Carolina and Cincinnati Sections.

Committee Reports to Board

Reports were received from the Society's Committee on Publications; the Committee on Professional Conduct, which had under consideration five matters relating to alleged unethical conduct; the Committee on Districts and Zones, whose recommendation that the present boundaries of Districts and Zones be continued was adopted by the Board; the Committee on Accredited Schools, which made a recommendation in regard to five applications from engineering schools; the Committee on Research; the Committee on Relations of the Federal Relief Agencies to Civil Engineers; the Committee on Local Sections; the Committee on Student Chapters, whose recommendation the Board adopted, giving approval to the formation of a Student Chapter of the Society at the Utah State Agricultural College; the Committee on Juniors; and the Committee on Public Education.

Provision for Defense of Members

A special committee composed of Board members reported, and the Board approved, acceptance of the principle that the Society should undertake upon application, under limitations and procedure to be developed by the Executive Committee of the Society, the defense of members accused and condemned, or deprived of position, without hearing.

Engineers' Compensation Under Emergency Relief Work

The methods by which engineers are being employed and the pay they are receiving under the Emergency Relief Act were discussed at length. The Executive Committee was instructed to continue to exert its influence to see that fair compensation be paid to such engineers, including those who are on a salary basis and those whose normal work in private practice is performed on a fee basis.

Future Meetings of Board and Society

The Board decided that its next meeting would be held at Miami, Fla., in the early part of April in conjunction with the meeting of the Florida Engineering Society; that the Annual Convention of the Society would be held at Los Angeles in the early part of July; and that a Fall Meeting of the Society would be held at Birmingham, Ala.

Budget Adopted

Among many other details of administration, the Board adopted the budget for the year 1935.

Disclaimer of Official Representation

The Board directed the Secretary to make the statement that the Society has no official representative on the newly formed National Society of Professional Engineers.

Recommendations of Committee on Aims and Activities Adopted

The Committee on Aims and Activities, a special committee consisting of three Board members and four non-Board members, reported to the Board, making several recommendations which the Board considered item by item. In brief, the Secretary is to add to his staff a man who under his direction shall function as a Field Secretary to develop contacts with Local Sections and the membership at large in order that they may be assisted in the local activities which they may undertake. The committee also recommended, the Board approving and making the necessary appropriation, that the Directors and Vice-Presidents make more frequent visits to the Local Sections in their respective Districts and Zones.

The Board also approved the recommendation of the Committee on Aims and Activities that in so far as practicable a Junior be added to every committee of the Society, of the Technical Divisions, and of the Local Sections in order that the Junior membership of the Society may recognize that it has a part in the administration of the Society's affairs and in order that the committees may have the benefit of the point of view of the younger men of the profession.

Upon the recommendation of the same committee, the Society is to engage in more extensive publicity, both for the Society and on behalf of civil engineers, indicating the service which they render to the community, this program to be carried out under the auspices of the Committee on Education of the Public.

Helping Engineers Under Civil Service and Extending Registration

The Committee on Aims and Activities also recommended that the Board give endorsement to the correction of abuses of the Civil Service laws and regulations and the improvement of the engineer's position under Civil Service regulations. It also recommended endorsement of engineers' registration laws in states where they do not now exist and the improvement of registration laws in states where inadequate laws are now on the statute books. The Board adopted both of these recommendations. The staff is to render all practicable assistance where movements to these ends are undertaken.

Meeting of the Incoming Board of Direction—Secretary's Abstract

THE Board of Direction met at the Headquarters of the Society on January 17, 1935, with President Arthur S. Tuttle in the chair; and present George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Barbour, Burdick, Crawford, Dewell, Eddy, Etcheverry, Ferebee, Hammond, Hogan, Horner, Leisen, McDonald, Morse, Noyes, Perry, Poole, Reed, Riggs, Sanborn, Sawyer, Sherman, Stabler, Trout, and Wilkerson.

Budget for Coming Year

The budget for the year 1935, as recommended by the outgoing Board, was considered and adopted.

Approval of Outgoing Board Actions

The various matters presented to the outgoing Board were considered and the actions thereon were approved as the actions of the incoming Board.

Committees Appointed

Upon recommendation of the President, the following committee personnel was approved, with authority for him to fill any vacancies.

EXECUTIVE COMMITTEE: Arthur S. Tuttle, Chairman; Harrison P. Eddy, Alonzo J. Hammond, John P. Hogan, and Donald H. Sawyer.

COMMITTEE ON DISTRICTS AND ZONES: B. A. Etcheverry, Chairman; Frederick H. McDonald, Herman Stabler, and C. Arthur Poole.

COMMITTEE ON PROFESSIONAL CONDUCT: Ralph J. Reed, Chairman; J. P. H. Perry, Henry E. Riggs, James F. Sanborn, and Theodore A. Leisen.

COMMITTEE ON PUBLICATIONS: Henry J. Sherman, Chairman; F. A. Barbour, W. W. Horner, O. H. Ammann, and Charles B. Burdick.

COMMITTEE ON MEMBERSHIP QUALIFICATIONS: E. N. Noyes, Chairman; Frederick H. McDonald, Herman Stabler, Howard S. Morse, and C. Arthur Poole.

COMMITTEE ON RESEARCH: George E. Beggs, Chairman, term ending January 1936; Thorndike Saville, term ending January 1937; Fred C. Scobey, term ending January 1938; H. de B. Parsons, term ending January 1939; and Charles B. Burdick, Contact Member.

COMMITTEE ON LOCAL SECTIONS: A. T. Dusenbury, Chairman, term ending January 1936; V. H. Cochrane, term ending January 1937; Andrew P. Rollins, term ending January 1938; E. B. Black, term ending January 1939; and James L. Ferebee, Contact Member.

COMMITTEE ON JUNIORS: J. T. L. McNew, Chairman, term ending January 1936; Charles M. Davis, term ending January 1937; F. W. Green, term ending January 1938; Howard R. Green, term ending January 1939; and E. N. Noyes, Contact Member.

COMMITTEE ON STUDENT CHAPTERS: C. C. Williams, Chairman, term ending January 1936; R. L. McCormick, term ending January 1937; H. W. Hanly, term ending January 1938; Glen E. Edgerton, term ending January 1939; and Thomas J. Wilkerson, Contact Member.

COMMITTEE ON ENGINEERING EDUCATION: Clarence L. Eckel, Chairman, term ending January 1936; R. H. Ford, term ending January 1937; Robert L. Sackett, term ending January 1938; Joseph W. Barker, term ending January 1939; and Ivan C. Crawford, Contact Member.

COMMITTEE ON PUBLIC EDUCATION: Abel Wolman, Chairman, term ending January 1936; L. J. Johnson, term ending January 1937; Van Tuyl Boughton, term ending January 1938; Theodore R. Kendall, term ending January 1939; and Henry J. Sherman, Contact Member.

COMMITTEE ON REGISTRATION OF ENGINEERS: James L. Ferebee, Chairman, term ending January 1938; Donald M. Baker, term ending January 1936; Charles H. Paul, term ending January 1937; Joseph Jacobs, term ending January 1939; and W. W. Horner, Contact Member.

COMMITTEE ON FEES: Enoch R. Needles, Chairman, term ending January 1938; Walter W. Colpitts, term ending January 1936; David B. Steinman, term ending January 1937; J. V. Davies, term ending January 1939; and James F. Sanborn, Contact Member.

COMMITTEE ON REGIONAL MEETINGS:

Annual Meeting: John P. Hogan, Chairman; O. H. Ammann, J. P. H. Perry, James F. Sanborn, and Charles E. Trout.

Spring Meeting: Donald H. Sawyer, Chairman; Frederick H. McDonald, E. N. Noyes, Herman Stabler, and W. W. Horner.

Annual Convention: Henry D. Dewell, Chairman; Ivan C. Crawford, B. A. Etcheverry, Ralph J. Reed, and Theodore A. Leisen.

Fall Meeting: Henry E. Riggs, Chairman; F. A. Barbour, Charles B. Burdick, James L. Ferebee, Howard S. Morse, Henry J. Sherman, Thomas J. Wilkerson, and C. Arthur Poole.

COMMITTEE ON TECHNICAL PROCEDURE: Arthur S. Tuttle, Chairman; George E. Beggs, Henry J. Sherman, Henry D. Dewell, Charles E. Trout, George T. Seabury, Secretary, and the chairmen of the ten Technical Divisions.

COMMITTEE ON PROFESSIONAL ACTIVITIES: Arthur S. Tuttle, Chairman; James L. Ferebee, E. N. Noyes, Thomas J. Wilkerson, Ivan C. Crawford, Henry J. Sherman, W. W. Horner, James F. Sanborn, and O. H. Ammann; and George T. Seabury, Secretary.

COMMITTEE ON ACCREDITED SCHOOLS: M. L. Enger, Chairman, term ending January 1936; J. G. Bennett, term ending January 1937; Franklin Thomas, term ending January 1938; John C. Riedel, term ending January 1939; and B. A. Etcheverry, Contact Member.

COMMITTEE ON ALFRED NOBEL PRIZE: George B. Pillsbury.

COMMITTEE ON CONSTRUCTION LEAGUE: John P. Hogan, with Wilson T. Ballard as alternate; and Alonzo J. Hammond, with Harrison P. Eddy as alternate.

Final Ballot on Society Officers for 1935

33 West 39th Street
New York, N.Y.
January 9, 1935

To the Eighty-Second Annual Meeting
American Society of Civil Engineers:

The tellers appointed to canvass the ballot for officers of the Society for 1935 report as follows:

Total number of ballots received		2,887
Deduct:		
Ballots from members in arrears of dues	37	
Ballots not signed	50	
Ballots with illegible signature	4	
Ballots with printed signature	1	
Ballots from members who have died since voting	1	
Total withheld from canvass		93
Ballots canvassed		2,794
For President		
Arthur Smith Tuttle	2,777	
Scattering	9	
Blank	8	2,794
For Vice-Presidents		
Zone II:		
Donald Hubbard Sawyer	2,750	
Scattering	11	
Blank	33	2,794
Zone III:		
Henry Earle Riggs	2,773	
Scattering	0	
Blank	21	2,794
For Directors		
District 3:		
Charles Arthur Poole	2,763	
Scattering	1	
Blank	30	2,794
District 5:		
Herman Stabler	2,753	
Scattering	6	
Blank	35	2,794

District 7:		
James Lumsden Ferebee	2,762	
Scattering	0	
Blank	32	2,794
District 8:		
Charles Baker Burdick	2,764	
Scattering	2	
Blank	28	2,794
District 9:		
Howard Scott Morse	2,763	
Scattering	0	
Blank	31	2,794
District 12:		
Ivan Charles Crawford	2,750	
Scattering	7	
Blank	37	2,794
District 16:		
Theodore Alfred Leisen	2,756	
Scattering	1	
Blank	37	2,794

Respectfully submitted,
THEODORE REED KENDALL, *Chairman*

B. S. Voorhees	R. S. Saunders	Albert W. Buel
John J. Cope	Chas. C. Armstrong	F. A. Rossell
Charles D. Thomas	James A. Darling	J. J. Hennebique

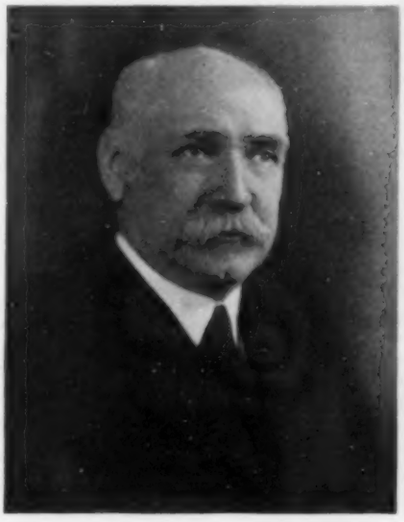
Tellers

Francis Lee Stuart, Past-President, 1866–1935

NEWS OF THE SUDDEN death of Francis Lee Stuart, president of the Society in 1931, came as a shock to his many friends in the Society, at the beginning of the Annual Meeting. He had intended to participate in the events of the week at Society Headquarters and, on January 15, was preparing to leave his home at Essex Fells, N.J., when he was stricken.

Born in Camden, S.C., on December 3, 1866, he was educated at Emerson Institute, in Washington, D.C. At the age of 18 he entered the employ of the Baltimore and Ohio Railroad, thus initiating a career devoted largely to railroad work. As a young man he deliberately sought experience rather than financial return, and for 13 years filled positions ranging from that of resident engineer on construction to that of operating superintendent. One of his first jobs was on the double tracking of the railroad from Rockville, Md., to Washington, D.C.

In 1897 he was given an opportunity to serve as assistant engineer on the Nicaragua Canal Commission. In this capacity he fought jungles and jungle fever for three years while making canal surveys in the eastern part of Nicaragua and a hydrographic and triangulation survey of Lake Nicaragua. Twice he was forced to return to the States to recuperate from attacks of fever. For a time, in Washington, D.C., he supervised the estimates of various canal projects.



THE LATE FRANCIS LEE STUART
President of the Society in 1931

Attracted again to railroad work, he reentered the employ of the Baltimore and Ohio in 1901 as engineer of surveys, in which position he devoted his efforts to lowering the ruling grades of the trunk lines from 0.3 per cent to 0.1 and 0.15 per cent. Beginning in 1905, for five years, he served the Erie Railroad as its chief engineer during a period of rapid expansion and improvement of the trackage of the system. In 1910 he again returned to the Baltimore and Ohio, where for the next five years he occupied the position of chief engineer. Here he was engaged on an intensive program of heavy railroad construction, including double tracking, terminal facilities, grade reduction, and coal-loading docks.

In 1915, sensing that the railroads were in for a "period of stagnation" as he described it, he left the Baltimore and Ohio to enter private practice and opened a consulting office in New York, N.Y. During the World War he served the Government for a dollar a year, developing terminal facilities for the transportation of supplies to France, and improving the railroads of the country under the U. S. Railroad Administration.

In the course of the next few years he was the consulting expert on the construction of the Cunard piers along the Hudson River in New York. He also advised the Niagara Hydro-electric Power Commission, the Port Development Commission of Baltimore, the Port of New York Authority, the Transit Advisory Board of Philadelphia, the Greater Harbor Commission of 200 of Los Angeles, and the Great Lakes Regulatory Commission. He made an extensive study of the transportation facilities of Manhattan and was consulting engineer on the proposed bridge over the Hudson River at 57th Street, New York.

In the Society he served as Director for the three years, 1909 to 1911; as Vice-President in 1920 and 1921; and as President during 1931. He was an active worker on the committees of the Society, including the Committee on Publications, the Finance Committee, the Library Committee, and the Committee on the 57th Street Property. Also he represented the Society on the board of trustees of the Engineering Foundation and served as president of that board in 1930. In addition to these duties he found time, in spite of his active career, to contribute to the publications of the Society.

Taking office in 1931 at the beginning of the depression, Mr. Stuart was much concerned that the engineer should give liberally of his talents for the upbuilding of the country's prosperity. He believed and stated that each engineer owed to his profession and to his country a duty to be eager for public service and for greater usefulness, and that he should take a serious part in the solution of the many problems that were besetting the citizens of the nation. He applied himself diligently during and following his incumbency to emphazing these constructive ideas. Without doubt his activities had a stimulating effect on engineers in their efforts throughout the country. This was his great contribution to the well-being of the profession.

He is survived by his widow and four married daughters. He and Mrs. Stuart made their home at Essex Fells, N.J. Mr. Stuart had a host of friends. He was a delightful companion, kindly in all his ways, and his genial personality will be missed by all those who knew him.

Post-Meeting Cruise to Bermuda a Great Success

IT WAS A CHEERFUL party of 35 members and guests that sailed on Saturday afternoon, January 19, for the post-Meeting cruise to Bermuda. The Monarch of Bermuda, combining the features of a well-run hotel and club, furnished deck sports, dancing, swimming, and other amusements, which were thoroughly enjoyed. In Bermuda the party stopped at the delightfully situated Bermudiana Hotel, where everything possible was done to make the stay pleasant. In addition to a variety of sightseeing excursions, there was engineering interest in the Pembroke reclamation project, the horizontal wells, and the quarrying of the building stone of which most of the structures on the island are made.

Another of the high spots was the hospitality offered by Daniel Moran, M. Am. Soc. C. E., who has his winter home in Tuckerstown. Much interest was manifested in the cruise, and it was voted to be an ideal method whereby a congenial party of Society members can add the finishing touches to an enjoyable Annual Meeting.

Welfare Accomplishments of the Society

Committee on Aims and Activities Reports Numerous Successes During Recent Years

A MOST illuminating review of the Society's non-technical activities has been made available through a committee appointed by the Board of Direction in October 1934 and instructed, among other things, "to study the present activities of the Society with respect to human relations, welfare, and public relations of the Society and its members." This group, now known as the Committee on Aims and Activities, has delved intensively into the problems assigned to it and has embodied its findings in a report to the Board. The following graphic summary, which appeared as an appendix to that report, is reprinted by order of the Board, for the enlightenment of every member.

THE ACTIVITIES of the Society towards the improvement of the employment situation of salaried engineers and in behalf of engineers in private practice and their employees have greatly impressed your Committee. A comprehensive report made to us by the Secretary of the Society at our request clearly demonstrates the wide ramifications of such activities, the energy with which the problems have been attacked, as well as the results obtained. We believe a digest of what the Society has done and is doing in behalf of its members and the profession should be made a matter of record.

While some of this work in behalf of the profession is known in a general way, a great deal has been done without any publicity whatsoever and necessarily so, because definite results could not be announced in many instances. Furthermore the contacts established were of a continuing nature and frequently such that publicity as to the contact or as to the results involved the risk of impairing the relationship. Several situations are in process at this moment, which it seems best be not now openly discussed. The details that follow, therefore, embrace only those matters which it appears may properly be disclosed.

The work has been so diversified in character and wide in scope, that the summary of activities and accomplishments is presented, for the sake of simplicity, under three general broad subdivisions.

1. Operations initiated by the Board of Direction and carried on by committees under authorization of the Board.
2. Operations by organizations through which the Society acts jointly with other societies.
3. Operations by Society officers and members.

1. ACTIVITIES UNDERTAKEN AT THE INSTANCE OF THE BOARD OF DIRECTION OR BY COMMITTEES AUTHORIZED BY THE BOARD

COMMITTEE ON PUBLIC WORKS

In the spring of 1932, a group of some 16 members of the Society proposed as a measure to revive industry and employment an extension of Federal credit for the construction of worth-while delayed public works projects. This principle was approved by the Executive Committee of the Society and a resolution was adopted urging acceptance of the principle by the Congress of the United States. A Committee on Public Works was appointed and given an appropriation to further the proposed program. This committee carried on a campaign of education among members of Congress and worked closely with sympathetic congressional leaders.

At the request of President Hoover, the committee undertook a survey to determine the kind and value of delayed public works throughout the country and reports of its findings as furnished through the Local Sections were transmitted weekly to the President.

As a result of this committee's efforts, the Society can take its share of credit for the enactment of the Emergency and Relief Act of 1932, whereby under the Reconstruction Finance Corporation, public works were constructed, employing, directly and indirectly, several thousand engineers. The subsequent Public Works Administration, which was inaugurated under Title II of the National Industrial Recovery Act, in 1933, and which has provided work for other thousands of engineers, similarly should be credited in part at least to the very intensive work of the Society's Committee on Public Works. These efforts were carried on under the instructions of the Board of Direction and at Society expense. Under the FERA and in its state organizations, under the RFC and the PWA, it appears that approximately 40,000 engineers and engineering assistants have been temporarily reemployed.

ENGINEERING DIVISION OF THE CODE OF FAIR PRACTICE

When the National Recovery Administration was set up under the provisions of the National Industrial Recovery Act in 1933, the Construction League of the United States sponsored a group of volunteers representative of the engineering, architectural, and contracting interests of the industry, which discussed the advisability of a Code of Fair Practice for the Construction Industry. Chapter I of the Industry Code contains all the features that could be made applicable to the three major branches of the industry—design, general contracting, and subcontracting.

Because of the enthusiasm of the contractors and architects to draft Code chapters covering their functions, it was considered advisable that the engineering point of view be represented. The Board of Direction appointed two members of the Society to represent the engineering interests. Subsequently, the Board appointed and financed a Code Committee authorizing it to associate with itself engineers of other than civil engineering interests. Under the auspices of this Code Group, a draft of a Code related to the conduct of engineering practice has been continuously before the National Recovery Administration. In the preparation of this Engineering Code, all Local Sections were asked to set up committees for the collection of information on salaries that were prevailing in their respective areas. Although the proposed schedule of salaries was not permitted, under NRA rulings, to be included in the Code, much valuable information was obtained from the 28 Local Sections that made studies and reported their findings.

SALARY AND EMPLOYMENT SURVEYS

Salary and employment surveys initiated by the Board and carried out by the Society's Committee on Salaries, need special mention on account of the stupendous amount of work involved in the collection and collation of the information and the widespread use that has been made of the committee's work.

SALARY SURVEY

The Committee on Salaries in the fall of 1930 sent a questionnaire to the 15,000 members of the Society and to some 5,000 additional engineers comprising the heads of state engineering departments, city and county engineering organizations, and to railway and utility executives. From the information collected a report was prepared showing the relative salaries for different classes of engineering employment, as well as salary information covering several years preceding the report. These data were useful in many ways. For example, they were used in protesting against drastic salary cuts proposed for the Arizona State Highway organization; for the engineering employees of Trenton, N.J.; and in other instances.

EMPLOYMENT SURVEY

The Committee on Salaries conducted a further survey during the winter of 1932–1933 to determine the degree of unemployment among civil engineers. This survey also gave information of the effect of the depression on the income of consulting engineers and on their employees, both as regards curtailment of employee services and reduction in pay.

SALARY REDUCTIONS

From the information collected since its beginning in 1928, the Committee on Salaries prepared and submitted a report in October

1933, which indicated appropriate reductions as of October 1, 1933. This report was intended to afford resistance to the then general salary reductions being applied to engineers as segregated groups, by state departments, cities, and other governmental subdivisions. The report and a diagrammatic representation of the findings was approved by the Board and published in CIVIL ENGINEERING. The cooperation of the Bureau of Public Roads was sought to resist the cuts being made in the salaries of state highway engineers.

PREVAILING SALARIES

In the Spring of 1934, the Committee on Salaries prepared a report on "Prevailing Salaries of Civil Engineers," based on a survey of the salaries actually paid to some 16,000 engineers and engineering assistants in the highway departments of the 48 states for 1930 and 1933, and from engineer salary data furnished by the Society's Local Sections and from other sources. The report is unique in that by applying factors to base rates the prevailing rate, in consideration of kind of position, location, and population, is easily obtained. This report was amended later in the year, as a result of many additional data, both reports being approved by the Board and published in CIVIL ENGINEERING.

The report on prevailing salaries was drafted for the primary purpose of establishing rates of pay for technical men on emergency relief and on public works operations, and was prepared specifically at the request of the President of the Society as a result of his contact with Federal officials. The report was produced to meet a need felt by these officials and to provide support to them in their rulings to the effect that salaries to be paid engineers were to conform to those that were prevailing in the different localities. Rectification has been made of disproportionate compensation to engineers in cases reported to the national administrators by the Society's officers.

EMPLOYMENT CONDITIONS IN RUSSIA

As a result of action at the 1931 Annual Meeting, the Board of Direction appointed a committee to investigate and report on conditions of engineering employment in Russia. This report was published in CIVIL ENGINEERING and contained suggestions to be incorporated in contracts by American engineers for work in Russia. The recommendations have been of value in negotiating improved contracts for Russian engagements. While in general the findings showed that the Russian Government lived up to its contract provisions, it was suggested as possible to include many clauses in such contracts, for instance, provisions for importation, free of duty, of commodities not easily obtainable in Russia, to ensure proper medical or hospital treatment in cases of sickness—facilities that otherwise could not have been obtained except at great expense.

UNEMPLOYMENT RELIEF

In October 1931, at the request of the Board, the Local Sections of the Society were urged to organize to take care of local relief problems among engineers. A member was added to the Society staff for the purpose of gathering information on the extent of unemployment among the various Sections, and to assist the development of programs to be carried on locally to care for unemployed engineers. As a result, valuable information was gathered which has been used in a number of similar surveys by other groups. Examples of extensive local organizations to aid unemployed engineers are those at Boston, Philadelphia, and New York. The organization in New York, known as the Professional Engineers' Committee on Unemployment or the P.E.C.U., was organized through the initiative of the Society's Local Section's President, and the salaries secured for engineers as a result of its operations at the close of its first three years of work total nearly $5,000,000. The P.E.C.U. has collected more than $200,000 from employed engineers, has registered more than 9,000 technical men, both members and non-members of societies, of whom more than 5,500 have been placed in positions. Elsewhere about the country similar groups were formed or leading members of the Society acted individually for their Local Sections in the placing of engineers in remunerative positions.

NATIONAL RELIEF FUND

The committee in charge of the National Relief Fund has rendered very helpful assistance to engineers in distressed circumstances. In general, the fund has been made available only to men in isolated places, away from Local Section contacts, or to American engineers stranded abroad. In this way it has made the assistance of the Society effective in an unusual manner.

REGISTRATION OF ENGINEERS

For nearly a dozen years a committee appointed by the Board of Direction has been continuously engaged upon the subject of the registration of engineers. In January 1925, it developed a Proposed Uniform Registration Law, to be used as a model law in those states where the licensing or registration of engineers was contemplated. Since that time continuously the committee has cooperated with all the engineering organizations interested in the registration problem. From time to time amended drafts of the original law have been brought out, and in 1932 a draft designated as the Model Law was produced which was believed to incorporate all the suggestions that experience indicated as advisable and practicable. The Board of Direction has gone on record as favoring the registration of engineers and the Society's staff has assisted in many instances where the proposal to secure registration laws has come up. Undoubtedly, the Model Law has served to guide legislation effecting the registration of engineers, which at present is operative in 28 states.

PUBLIC EDUCATION

The Committee on Public Education has done good work in the way of informing the public about what the civil engineer does, through the medium of news items. The Committee has made a collection of broadcast addresses on civil engineering subjects and has itself initiated some radio talks.

MANUALS OF ENGINEERING PRACTICE

When it issued in 1927 the Code of Practice as Manual No. 1, the Board of Direction initiated a new and novel publication program which probably most members have viewed as technical in character and content. This, however, is not the case. Manual No. 1 was a comprehensive discussion of non-technical relationships between engineers, contractors, clients, the Government, and the public. Among the Manuals that have had wide use and influence were those prepared by the Committee on Fees and issued as Manuals Nos. 5 and 6. Manual No. 5 is entitled "Charges and Methods of Making Charges for Professional Services." Manual No. 6 is a summary of the information in Manual No. 5 and was assembled with particular attention to its use for the guidance of clients. An article to inform the membership about the provisions of the recent Securities Act for the guidance of those who may be called upon to render services on work involving the issuance of these securities, has been published recently in CIVIL ENGINEERING.

2. ACTIVITIES OF THE SOCIETY JOINTLY WITH OTHER ORGANIZATIONS

The principal agencies through which the Society acts jointly with other societies are the American Engineering Council, the Construction League of the United States, the Engineering Societies Employment Service, the Engineers' Council for Professional Development, the United Engineering Trustees, the Engineering Societies Library, and the Engineering Foundation.

AMERICAN ENGINEERING COUNCIL

The American Engineering Council, of which the Society is a member body, is representative of some 22 national, state, and local engineering organizations. While one of the Council's primary purposes is to keep informed about and to express the engineering viewpoint on national legislation affecting the profession, it is also engaged in numerous efforts of general interest to the profession. Among such activities of the Council may be mentioned its analysis of the causes of the present business depression and proposed measures to dampen or prevent business cycles. The Council maintains close liaison with the various Federal authorities and has supported the budgetary requests of many of the Federal departments and bureaus engaging engineers. Through the Council the Society has acted upon a host of other matters, some large, some small, but all in behalf of the engineering profession or of the public upon engineering matters.

Changes in Engineering Plans. On request of the Society, the

Council is now endeavoring to rectify procedures wherein designs submitted by engineers in private practice under agreements with Federal agencies were altered without the knowledge and consent of the designers. Investigation has also been initiated of the understanding that the cost of such alteration work is charged against the fee of the engineer who made the plans.

Uniform Lien Law. Several years ago the Council collaborated with other agencies in the establishment of a Uniform Lien Law, which would protect the interest of engineers in private practice in the case of liens placed upon any of the parties involved in a contract.

Employment Survey. Through the Council, plans are now being completed rapidly for a spot census by the U. S. Bureau of Labor Statistics of some 125,000 engineers of all classes. This survey is expected to determine many questions regarding employment and it is hoped will also disclose new avenues leading to the employment of engineers. This work is being financed, in part, by the Society.

The preceding enumerated activities of the American Engineering Council by no means cover all its operations. The Council has been asked to investigate and report on many situations affecting engineers, and the close acquaintanceship of the Council with Federal officers and Federal operations is valuable in this respect.

ENGINEERING SOCIETIES EMPLOYMENT SERVICE

An Employment Service has been operated since 1918 as a joint agency by the four large engineering societies located in the building in New York where the Society has its headquarters. In 1925, a Chicago office was opened in cooperation with the Western Society of Engineers, and about six months later a San Francisco office was established in cooperation with the Engineers' Club of San Francisco and the California Section of the American Chemical Society. The Society has contributed $42,500 directly to the support of this national employment service.

In normal times, the Employment Service is self-supporting, but during the past four years, owing to the scarcity of positions and the inability of those who secured positions through the Service to pay the customary voluntary contribution, the Societies have found it necessary to subsidize the bureau's operations. The present annual cost is $18,400 per year, of which the Society's share is nearly $7,000.

In order to better contact with opportunities for engineers in Federal service, a representative of the Employment Service has recently been placed in Washington. The results so far obtained from this representative indicate that this close contact with Government officials will be well worth while.

CONSTRUCTION LEAGUE OF THE UNITED STATES

The Construction League of the United States is made up of member bodies, the principal ones being the Society, the American Institute of Architects, the Associated General Contractors of America, the Producers Council, and several other national organizations. It was first intended that the League should consist of round table conferences to discuss problems common to the construction industry, the thought being that through mutual understanding, difficulties could be better approached and solved. The Society joined the Construction League of the United States in April 1932, and contributed to the expenses in connection with the National Committee for Trade Recovery, which was sponsored by the League and organized for the purpose of giving expression to the demand for public works. This committee watched closely the operations of the RFC and held frequent conferences with its officials and assisted the Society's Committee on Public Works in the effort to liberalize the RFC procedures and establish the PWA.

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

About two years ago the Engineers' Council for Professional Development was organized. It consists of three representatives from seven member bodies—the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners.

These 21 representatives constitute the Council, which has established four committees, each representative of a definite phase of work which is esteemed to be of signal benefit to the profession. The nature of the work of the Council is indicated by the titles of these four committees—the Committee on Student Selection and Guidance, the Committee on Engineering Schools, the Committee on Professional Training, and the Committee on Professional Recognition.

The Council thus constitutes an agency of the entire profession, in all its aspects, to study and determine upon procedures designed to enhance the esteem of the engineer in the eyes of the public. Upon the determination of programs approved by all the collaborating organizations, the E.C.P.D. will offer itself or suggest some other medium to carry them out. It has suggested to the several cooperating societies a procedure looking toward the accrediting of engineering schools which has received unanimous approval, and the Council itself has been designated the agency to carry out the program. It is also studying several other phases of its objectives and through the various societies is making experimental tests of some of the features which it contemplates proposing for general adoption. Already the effort is being made to bring about a clear comprehension, not only on the part of engineers but also on the part of the public, of the minimum technical and social attainments to be required of an engineer.

The United Engineering Trustees, the Engineering Societies Library, the Engineering Foundation are joint agencies having functions wherein they act for the Society or through which the Society acts. In general, however, their functions are financial or technical and as such are not of a nature to be outlined here as planned movements directly intended to improve the status and conditions of employment of engineers.

3. OPERATIONS OF OFFICERS AND MEMBERS OF THE SOCIETY

EXTENSION OF FEDERAL MAPPING

The Society continuously, for more than three years, has supported the completion of the Federal maps in an effort to obtain Federal approval of programs that would afford reemployment to large numbers of engineers. The President and Secretary of the Society and the Chairman of the Society's Committee on Salaries called upon President Hoover in 1931 and urged an immediate expansion of the topographic mapping program of the United States. Since then, similar efforts have been continuous upon many Government officials, one result being that under the Civil Works Administration's operations, in the winter of 1933–1934, a temporary expansion of the Federal mapping program was approved and undertaken. The first work consisted primarily of an expansion of the triangulation and level control systems under the direction of the U. S. Coast and Geodetic Survey. Some 14,000 men were employed, 10,000 of whom were engineers.

Society officers have continued their efforts with Federal administrative officers and members of the Congress to have this work recognized, financed, and enlarged. In the last Congress the effort was to have an appropriation of $22,000,000 for the work. The Society placed an engineer in Washington, at its expense, to further this effort. Under the CWA operations a program of local control surveys was instituted and supervisors were appointed in the various states to carry on the local control surveys which were done under the requirements of the U. S. Coast and Geodetic Survey. Again, in this connection, the Society contributed financially to the coordination of the effort. The work is still going on in 21 states with about 2,300 engineers thus employed.

As a result of efforts of Society officers, upwards of $100,000 a year has been allocated for three years to branch offices of the U. S. Coast and Geodetic Survey, one a computing office for calculating survey notes which were some two years in arrears, and another office for the reduction of air photographs and development of coastal charts, bringing them up to date by inclusion of the latest information. These offices have continued in operation for the past three years, and some 300 engineers have found employment in those two offices alone during this period. Incidentally, practically all of the drafting tables required for these two offices were obtained by Society officers on gift or loan, and calculating machines, typewriters, and other such equipment were obtained at special rental rates in order that the maximum of the money available might go as salaries to reemployed engi-

neers. Also, space for the offices was generously donated for a period through efforts by Society officers.

REFORESTATION

Upon instructions of the Board of Direction, the Secretary urged with the administrator of the reforestation program the use of trained engineers in the design and supervision of roads, trails, bridges, water supplies, etc., as well as in the widespread land surveys in those areas which the Federal Government contemplated acquiring for reforestation purposes. Many engineers have found employment in this work, as well as in the operations of the National Park Service, where similar procedures were urged. It has recently been reported that while large numbers of engineers were employed on land surveys on the reforestation program, many local engineers were overlooked and engineers from other parts of the country utilized. In an endeavor to change the policy so as to employ local engineers wherever available and to prevent selection of incompetent men, the American Engineering Council has been asked to investigate and attempt to correct unfortunate situations as they may be disclosed.

GOVERNMENT COMPETITION WITH PRIVATE BUSINESS

As engineering designs were required for the preparation of applications for RFC and PWA credit, the business of engineers in private practice has been affected. In some instances, such plans were prepared by the regular engineering staff of the political subdivision interested and in other instances by engineers engaged in private practice. The President of the Society and others of its officers have had repeated conferences with Federal Administrative officials regarding details of procedure and certain rectifications and modifications of regulations affecting engineers in private practice have been effected. Through the American Engineering Council effort has also been made with the Supervising Architect of the Treasury Department to make use of engineers in private practice for work on buildings under its supervision.

PARTY CLEARANCE

The requisite of "party clearance" before appointment has been actively opposed. The Board of Direction condemned the requirement of party affiliation for any engineering position. This expression of the Board has been vigorously presented.

USE OF ENGINEERS ON RELIEF BASIS TO CARRY ON REGULAR MUNICIPAL PROGRAMS

As relief work under the CWA and FERA has gone forward simultaneously with the operations of the Public Works Administration, the expense to communities being different under the two operations, there has been a tendency for political subdivisions to attempt to use engineers under relief provisions to design and supervise regular work programs.

The officers of the Society have conferred with Federal officials to define the limits of such undertakings, and it has been ruled that work which normally would be done by a political subdivision must not be done on relief basis. In spite of this ruling, there is no question that normal programs of municipalities have been shifted to relief employees, or to regular employees released and placed on relief basis. As frequently as specific violations have come to notice, the President of the Society or other officials have made instant contact with Federal officials, to secure rectification.

The Society is now collecting data of specific instances where the elimination or the curtailment of the business of engineers in private practice has resulted from this form of governmental competition, inasmuch as all classes of engineers are involved. Conferences have been arranged by the American Engineering Council where these data are to receive the consideration of Federal officials concerned.

CIVIL SERVICE

Another effect of the relief measures adopted has been the breaking down of Civil Service regulations. Engineers with Civil Service positions have been laid off or given indefinite leaves of absence, only to have their places filled by persons selected without examination as to qualifications, or filled from relief rolls at relief wages. The Society's officers have protested in many instances of apparent violations of Civil Service requirements, not only in the respect above mentioned but in individual cases. Protest has also been made in instances where the title of the position indicated that it required an engineer but in which a non-professional man has been placed.

NEW YORK CITY ENGINEERING EMPLOYEES

In 1927, when effort was made by the engineers employed in the City of New York to obtain increases in salary, the Society rendered assistance. A group of selected consulting engineers called upon the mayor and other city officials in support of the request, and as a result the pay of some 3,600 engineers was increased, the aggregate amounting to approximately $2,500,000 yearly.

HOME LOAN SURVEYS

On being informed that the Home Owners' Loan Corporation had been refusing payment on some lot surveys, apparently on the ground that loans were not approved, the Society's officers have taken the matter up with the head of the Corporation. All Local Sections have been asked to forward to Society Headquarters information as to the extent to which this practice prevails throughout the country in order that further efforts may be made to secure rulings that will relieve engineers from this unjust burden.

APPOINTMENTS

The reputation of the Society is such that numerous requests have been made that it suggest members to fill important positions or to undertake important assignments. The Board of Direction some years ago authorized the President of the Society to comply with such requests from official bodies or other responsible sources. In the past two or three years these requests have been frequent, from municipalities, commissions, and from departments of the Federal Government. The Society's voluminous records of its members and its resources for determining up to the minute data have been called upon constantly.

LOCAL SECTIONS COOPERATION

Throughout the past two years or more a steady stream of letters has been sent to the presidents and secretaries of the Society's Local Sections advising of rulings obtained or promulgated by which, through the spreading of the information locally, individual engineers may know of their opportunities for reemployment or committees may be formed to carry out locally various procedures leading to the reemployment of engineers throughout the country. The accumulated effect has never been determined nor can it ever be fully known.

This summary tells of some of those efforts that the Society and its officers have essayed to improve the financial well-being of the members of the profession. It records, too, the tremendous measure of success attained. The Committee believes the facts should be made known to the membership—and indeed to those not members—who can have had no conception of what the dues of members of the Society have made practicable in behalf of the engineering profession.

J. P. H. PERRY, *Chairman*
F. A. BARBOUR, *Secretary*
F. H. McDONALD
A. B. PURTON
T. E. STANTON, JR.
E. O. SWEETSER
R. K. TIFFANY
Committee on Aims and Activities

January 2, 1935

The Library's Service Bureau

THE SERVICE BUREAU of the Engineering Societies Library aids engineers and technical men who, because of distance from New York or lack of time, cannot use the library in person. It searches for information on all phases of engineering, suggests books or magazine articles, prepares bibliographies, tells what is in the bibliographies by means of abstracts, supplies photoprints of material in the Library, and makes publications in foreign languages usable by providing accurate translations. The man who cannot visit the Library finds that the Service Bureau uses its facilities as he would himself if he were present.

Investigations of the Service Bureau are not limited to the extensive resources of the Engineering Societies Library, as the searchers in this bureau have access to all libraries in New York and use them to answer questions in fields more or less related to engineering.

The Bureau has served engineers in every state in the United States as well as in more than fifty foreign countries. In fact more than one-third of the total number of persons using the Library do so in absentia.

When a charge must be made for the service requested, the Service Bureau notifies the inquirer of the approximate cost before proceeding with the work. All paid services are rendered at cost. Further information concerning the Service Bureau can be obtained by writing, telephoning, or wiring the Engineering Societies Library at 29 West 39th Street, New York, N.Y.

Abstract of Annual Report of Committee on Publications for the Year 1934

THE REGULATION work of the Committee on Publications is largely concerned with passing on manuscripts submitted for PROCEEDINGS. As the basic technical publication of the Society, it deserves the most careful study to ensure the maintenance of the very highest standards. To assist it in its decisions, the Committee depends upon the reports submitted by the numerous reviewers to whom the several manuscripts are sent anonymously and who submit frank opinions dealing with the quality of the papers, the advisable improvements, and the suggested attitude toward acceptance or rejection. Frequently papers come to the Committee for repeated consideration before they are finally considered to be in the ideal form for printing. These operations accounted for the major part of the Committee's work during the year. The quality of the papers has been maintained and the reputation of the publication has been enhanced by the year's work.

The Committee has always felt responsibility to the various committees and Divisions which have sponsored and have submitted manuals for publication by the Society. For the last few years it has not proved feasible to print any of these manuscripts. The Committee feels sure that the long delay has only increased the interest of the members in the subjects covered, namely, Engineering and Contracting Procedure for Foundations, Erection of Steel Buildings, and Technical Procedure for City Surveys. The editing, proof-reading, and printing of these Manuals has proved a serious task for the editorial department, coming as it does as an additional burden upon an already heavy schedule. During the year, the supply of Manual No. 1, *Code of Practice*, became exhausted and this Manual was reprinted.

In an attempt to deal frankly with the membership in the matter of the underlying principles and practice in Society publications, the Committee has authorized the printing of a number of articles in CIVIL ENGINEERING, notably in the September and October issues. It has come to the attention of the Committee that these explanations have assisted in a number of cases in meeting legitimate questions and in strengthening the bond of confidence between authors, Committee, and editors.

All the activities of the Society, but particularly the publication work, suffered a severe loss in the death, in August, of Henry R. Buck, M. Am. Soc. C.E. During all his term of office on the Board of Direction, Mr. Buck was a member of the Committe on Publications, being chairman in 1933. He made an ideal chairman; he was faithful in every detail of his work and vitally interested in all Society publications. Every aspect of the Society work is the richer for the sincere efforts of Henry R. Buck.

In spite of the tendency for increasing costs, the Committee's work has been completed within its budget allowance. During the year, unit prices have advanced for paper and for printing CIVIL ENGINEERING. These adjustments account in part for the impossibility of showing any economy over the unit costs of 1933.

The Committee recognizes that its work is distinctly cooperative among a variety of efforts. Authors of Society papers have continued their attitude of genuine cooperation with the Committee. They and the Committee have seen the goal of idealism with a single eye. Equally helpful and indispensable has been the aid of a large number of members, particularly those who have given generously of their time and skill in the review of papers submitted for Society use. Their aid has been more than mere assistance; it has been invaluable, and whatever of wisdom or discretion has been exhibited in the choice of papers the Committee frankly admits is largely due to the generous collaboration of these conscientious reviewers. The efforts of discussers are also to be commended. Such members, in large numbers, have devoted their ability during the year to the analytical review, the discussion, and appraisal of technical papers. The Society publications are distinctly enriched by their efforts.

With certain improvements that the Committee has found desirable during the course of the past year, the general procedure for Society publications is contemplated for continuance during 1935.

Respectfully submitted,
JOHN H. GREGORY, *Chairman*
Frank A. Barbour
W. W. Horner
Edward P. Lupfer
Henry J. Sherman

Notes on the Annual Meeting

Brilliant Program Entertains Large Numbers from January 16 to 19, 1935

MEMBERS FROM far and near assembled on Wednesday, January 16, 1935, to join in the 82d Annual Meeting of the Society, to participate in an inspiring technical program, to enjoy a well-rounded group of social events, and to renew long-standing friendships. The combination left little to be desired.

GENERAL SOCIETY SESSION

Starting early on Wednesday morning, groups of members gathered in the tastefully decorated lobby of Society Headquarters in animated conversation. At ten o'clock the official meeting was called to order by President Harrison P. Eddy in the auditorium. A number of technical and financial reports and notices were presented, but the major interest centered in the various tributes to engineering personalities and accomplishments. First came the usual colorful ceremony of awarding Honorary Memberships. William L. Darling from St. Paul, and Robert Ridgway from New York, were present in person to receive this high distinction, while the late Milo S. Ketchum was represented at the ceremony by his son, Milo S. Ketchum, Jr.

Awarding the Society medals and prizes also called forth great interest and applause. The large attendance gave spontaneous acclamation to these honored authors who have contributed so eminently to technical advancement through Society publications.

Interest also centered in another feature of the morning session, the reports of the chairmen or representatives of several Society committees which have been laboring valiantly for the profession during the past year. These reports were necessarily condensed but gave a clear impression of the work being done by these committees. Immediately following came another of the high lights of the session, when the tellers reported on the votes for Society officers for 1935. The incoming President, Arthur S. Tuttle, was conducted to the rostrum, was appropriately introduced to the assemblage by retiring President Eddy, and responded with fitting remarks, to the continued plaudits of all present.

IMPORTANT TECHNICAL DIVISION MEETINGS

Following lunch and the succeeding hour of sociability, four of the Technical Divisions gathered at 2:30 in three simultaneous sessions, all in the Engineering Societies Building. The Waterways Division discussed at length the Cape Cod Canal and the important problem of marine wood borers. The great significance and value of national mapping engaged the attention of a large audience in a meeting of the Surveying and Mapping Division. Meanwhile, a joint session of the Construction and Highway Divisions featured the subject of construction in the interest of highway safety.

These technical sessions were continued all day Thursday with different topics but equal interest. A symposium on "Common Sense in Structural Design" called for extensive discussion during the morning session of the Structural Division. In the afternoon

the same Division discussed its committee reports in detail and also the topic of the pressure of fluid concrete.

A joint meeting was enjoyed by the Power Division in association with the Hydraulics Division of the American Society of Mechanical Engineers. During the morning session the various methods of fluid measurement were discussed. In the afternoon the same Divisions devoted a long session to the many problems of engineering work in the Tennessee Valley.

Similarly, the Sanitary Engineering Division held two sessions, including business and technical features. Industrial sanitation, sewage disposal in New York City, pre-treatment of sewage for grease and oil removal, spray-drying for sludge, and chemical treatment for sewage, vied with one another for their share of discussion. A number of committee reports were also received and subjected to comments from the floor.

So extensive and important were the subjects considered by the City Planning Division that it also held two sessions. Division business, an account of Milwaukee park activities, and papers on city planning during the depression occupied a full morning. The afternoon session opened early to provide sufficient time for adequately treating slum problems, real property inventories, traffic engineering, and the relation of planning agencies in various political and civic entities.

It is indeed fortunate that no more than four simultaneous meetings had to be accommodated. As it was, the facilities of the Engineering Societies Building were taxed. The sessions were enthusiastic and attracted generous attention from members, both in attendance and in participation. Detailed accounts of the technical papers must await the printing of abstracts in the March and April issues of CIVIL ENGINEERING.

ENTERTAINMENT PROVIDED FOR ALL

While the men were busy trying to solve the difficult problem of choosing among the attractive technical programs, the ladies were not neglected. The Engineering Woman's Club was open continuously for the convenience of the ladies. In particular, a feature was arranged for Thursday afternoon that always proves popular. This consisted of a fashion show followed by a tea, at the Hotel Roosevelt. That evening the Engineering Woman's Club was thrown open for bridge and other forms of sociability. A large and enthusiastic group of women enjoyed all these events.

Without fail, the dinner, reception, and dance on Wednesday evening is the social high light of the Annual Meeting. This year the Hotel Roosevelt, as in the past, provided its beautiful setting for the event. Fine music, an excellent dinner, and a reception to the new President and Honorary Members, followed by dancing, filled the evening, to which the final touch of perfection was added by the congeniality of the large group that attended. It goes without saying that the reception and dance were voted on all sides a complete success.

The male contingent had to be somewhat exclusive on the occasion of the Smoker, Thursday evening, for the simple reason that the accommodations of the Engineering Auditorium were taxed to their physical limits. The cause of this was clear—Dr. William Beebe is a renowned scientist and speaker, and his address, "Five Hundred Fathoms Down," surpassed the most sanguine expectations and held every auditor spellbound. It was with regret that his hearers saw this part of the meeting come to an end. Immediately they made their way to the fifth floor for the regular Smoker, breaking up into many groups to facilitate conversation, which lasted to a late hour.

ENGINEERING TRIPS HOLD WIDE INTEREST

Following the practice of previous years, a number of brief trips, mostly to places of decided engineering interest, were scheduled for Saturday morning. A large number of members took advantage of this opportunity to view, in personally conducted groups, some of the multitude of engineering and scientific activities of a great metropolis.

But the special inspection feature of the meeting was the all-day excursion on Friday, January 18, to Trenton, N.J. The objective was the plant of the John A. Roebling's Sons Company. This organization has played an important part in engineering construction, notably in the field of American suspension bridges. Leaving New York on a special train from Pennsylvania Station, the party went direct to Roebling, N.J., where they watched the manufacture of open-hearth steel, the rolling of steel rods, and the drawing of both copper and steel wire. After lunch, the train proceeded to Trenton, N.J., to visit another huge plant, making wire rope, both of minute and very large size. The test of a pair of $2^{11}/_{16}$-in. suspender ropes for the Golden Gate Bridge to their 2,250,000-lb breaking strength was a spectacular feature.

Numerous attendant events took place in the course of the week. For example, the Society's Board of Direction met on Monday and Tuesday, and the annual dinner of past and present officers of the Society was held at the Engineer's Club on Tuesday evening. The regular annual meeting of the New York State Sewage Works Association was also held in New York on Tuesday, occupying the full day. In the evening the association held a joint dinner with the Sanitary Engineering Division of the Society.

A dozen or more groups of college alumni and honorary fraternities found the Annual Meeting week a convenient time for scheduling lunches and dinners for their members. Although the civil engineers predominated at these meetings, and the out-of-town visitors were the special guests, many local alumni availed themselves of this opportunity for social enjoyment.

The record of approximate attendance, which was kept for the various events, shows that a total of 1,900 registered, of which about 200 were students.

One other notable event should be mentioned. Starting on Saturday afternoon, as the regular events of the Annual Meeting were coming to an end, one of the regular tours to Bermuda included a special party of about 35 members and guests.

On whatever basis the 82d Annual Meeting of the American Society of Civil Engineers is judged, it must rank as one of the most successful of such assemblages. Many groups are responsible for this, but largely credit goes to the Committee on Local Arrangements, together with its Ladies' Committee. Authors, discussers, and entertainers also played a vital part. Perhaps those present at the meeting will remember most vividly, however, the personal contacts established or renewed. Old friends, long-forgotten incidents, and reminiscences that caused a hearty chuckle or a deep feeling of satisfaction—these are the dominant memories. Members seemed loath to separate and to leave the scene of so much personal pleasure and professional profit, but they consoled themselves and each other with the oft-heard farewell, "See you at the next Annual Meeting."

Epitome of Society Progress for Past Year

EXTRACTS FROM THE ANNUAL REPORT OF THE BOARD OF DIRECTION FOR THE YEAR ENDING DECEMBER 31, 1934

FOR FOUR full years, from 1931 to 1934, inclusive, civil engineers as a group have been victims of the depression. The year 1930 was the peak of all-time employment of civil engineers and the peak of all-time civil engineering salaries. The year 1933 found approximately 50 per cent of the civil engineers of the country without employment and the income of the profession shrunken to an even greater degree. In October 1933, the Civil Works Administration afforded reemployment, but at relief wages. Later, the Federal program of Public Works, and the Federal Emergency Relief Administration in their various ramifications, gave employment to many more. The close of 1934 found a large percentage of the civil engineers of the country at work, at something, although with greatly curtailed income and to an unfortunate extent upon work in which their capabilities have not been utilized to the full. It has been demonstrated, as a type characteristic of the civil engineer, that he prefers to be busily engaged at something even if he is paid little for it, or even if it is not to his liking.

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The activities of the Society during the past four years, and even more, have been addressed to such an extent to efforts to support salaries and the business conditions affecting civil engineers and to induce reemployment of engineers that this report might be devoted entirely to this feature; even then it would not afford more than an outline of what has been attempted and what has been accomplished.

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Without diversion of its attention from the development of the highest possible technical literature, and without lowering its requirements for membership, the funds contributed by its members

have made possible, through committees and individual effort within the past ten or twelve years, a wide program devoted to the improvement of the economic condition of the civil engineers of the country.

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The number elected as Juniors was 40 per cent in excess of last year and, of the older men in the Associate Member and Member grades, there was a 29 per cent increase. In recognition of the principle that the Society's real value is its "assets in men—not money," dues amounting to $57,773 were written off the books this year. A total of approximately $110,000 has been written off during the years of the depression. The net membership of 14,910, as of December 31, 1934, is 291 lower than last year, due largely to the dropping of 618 members who were in arrears and had paid dues for but one, two, or only a very few years. Reinstatement provisions have been adopted to relieve those dropped of the payment of a second entrance fee and of dues for the period during which they received no benefits from the Society.

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At the beginning of the year the budget was set up to effect expenditures $21,642 in excess of anticipated receipts. Economies resulted from continued reduction in size of publications, decrease in the number of meetings of the Board of Direction and of the Society, and continued reduction in salaries of the Staff. Adjustment of the Budget during the year increased the expenditures, but none the less the outcome for the year was not a deficit. Reemployment of members increased the anticipated income from dues by $22,500, and the increase in the anticipated advertising in CIVIL ENGINEERING contributed a large part of the remainder. Both items indicate improvement in general business conditions. Final payment was made on the mortgage, and the Society is now without any unpaid financial obligation of any kind. It should go forward rapidly in greatly increased service to its members and to the profession.

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There have been five meetings of the Board of Direction during 1934, and four meetings of the Executive Committee.

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The total number of applications for membership was 990, of which 768 were for admission (including 2 for re-admission) and 222 for transfer, an increase over the previous year.

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The losses by death during the year numbered 171.

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The Engineering Societies Library was used by 40,789 persons.

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The Employment Service has offices in New York, N.Y., Chicago, Ill., and San Francisco, Calif. The number of men placed during 1934 has averaged about 139 per month.

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Publications of the Society for 1934, include one volume of TRANSACTIONS (Volume 99), ten numbers of PROCEEDINGS, 12 numbers of CIVIL ENGINEERING, three Manuals, an Index to TRANSACTIONS, and a *Year Book*.

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The gross cost of publications, as determined by the bills actually paid during the year, and inclusive of salaries, has been $114,326.37.

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The attendance at the Reading Room during the year was 2,148. Two hundred and forty-four periodicals are regularly received. Included in this number are many foreign periodicals, also a number of literary magazines and several daily newspapers.

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Six meetings of 6 sessions were held during the year, as follows: At the Annual Meeting, at New York, N.Y., 2 (2 sessions); at the Annual Convention, at Vancouver, B.C., Canada (held jointly with the Engineering Institute of Canada), 2 (2 sessions); and 2 regular meetings held in the Engineering Societies Building, New York, N.Y.

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All but two of the Technical Divisions of the Society held sessions during the year. The meetings of the Divisions were marked by good attendance and interest and by an excellent group of technical papers. The total membership in the Technical Divisions is 14,882.

There are at present 57 Local Sections, the South Carolina Section, approved by the Board of Direction on October 3, 1934, having been added during the year. The name of the Chattanooga Section was changed to Tennessee Valley Section.

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There are at present 109 Student Chapters. The Ole Miss (University of Mississippi) Student Chapter was reinstated and the University of Georgia Student Chapter was disbanded during the year.

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The balance sheet accompanying the report of the Secretary shows that the assets of the Society total nearly $1,423,000, of which $493,000 represents the interest in the Engineering Societies Building, and $597,000 the value of the property on West 57th Street, New York, N.Y., formerly used by the Society as its headquarters. During the year the disbursements by the Society totaled $375,000, of which $230,000 was received in the form of dues and entrance fees, $22,000 from advertising, $52,500 from the rental of the 57th Street property, and $21,000 from bequests and income from various funds held in trust.

(The complete annual report of the Board of Direction for 1934 will appear in the February 1935 issue of Proceedings.)

Freeman Scholar to Be Appointed

AGAIN THIS YEAR a young engineer is to go to Europe under the Freeman Traveling Scholarship. In 1932 two men had enjoyed this privilege at the same time, and none went from this Society in 1933 and 1934. Now, in 1935, it again becomes possible for the Society to appoint a Freeman Scholar. Announcement is therefore made that this scholarship is open. Applications will be received up to June 1, 1935. Thereafter, it is expected that choice will be made promptly of the fortunate young engineer who will be privileged to enjoy a year of study of hydraulics and hydraulic practice in Europe under remarkably favorable auspices, starting possibly as early as July 1.

Among the qualifications for such a Freeman Fund Scholar are American citizenship, age between 24 and 35, graduation from a recognized engineering school, and the professional status of a junior teacher. Membership in the Society is considered advantageous. Not fewer than six letters of reference are required. These and various other necessary preliminaries are covered in a mimeographed announcement available on application to Society Headquarters.

A matter of such importance is not approached lightly or on the spur of the moment. Hence, this notice is being given well in advance so that ample time will be available to all those who are interested and eligible. The record of this award and of those young engineers who have gained immeasurably from enjoying its privileges, are evidence of the wonderful opportunity thus presented.

Progress of Engineers' Council for Professional Development

FOR A YOUNG organization, the Engineers' Council for Professional Development—known as the E.C.P.D.—has been accorded unusual recognition. This has been partly due to the widespread recognition of its timeliness and the need it meets, and very much also to the vision of its organizers. The Society, through its Board of Direction, has repeatedly gone on record as in agreement with its policies and its program.

Founded in 1932 as an agency of the united engineering profession to enhance the status of the engineer, the E.C.P.D. has completed the second year of its work. In entering on its third year it is carrying on various phases of its program with renewed activity. The procedure for developing a list of accredited schools has advanced through the experimental stage, and it is expected that early in 1935 active steps will be taken to carry on this accrediting. This work is under the Committee on Engineering Schools of the E.C.P.D., under the chairmanship of Dr. Karl T. Compton.

Two phases of the general work will require the cooperation and enthusiasm of engineers throughout the country. The first is that dealing with the selection and guidance of young men in the

secondary schools who are interested in entering engineering schools and who wish to follow an engineering career. The local sections of the engineering societies of the country are being requested to organize local committees and to make contact with the authorities in the secondary schools so that the advice and guidance of the engineers in the community will be made available to aid young men who wish to enter the engineering field. The procedures for this work are being developed by the Committee on Student Selection and Guidance, under the chairmanship of Robert L. Sackett, M. Am. Soc. C.E., Dean of the Pennsylvania State College.

The second phase of the program of the E.C.P.D. in which the engineers of the country are concerned is that dealing with the stimulation and development of the younger engineer to attain the standing of the full-fledged professional man. This work is being carried on under the guidance of Gen. Robert I. Rees, chairman of the Committee on Professional Training. This committee has developed a pamphlet of *Suggestions for Junior Engineers* which may be secured at 10 cents per copy, from the office of the Engineers' Council for Professional Development, 29 West 39th Street, New York, N.Y. This pamphlet contains a scheme of self-appraisal and a reading list for junior engineers which includes selected titles on natural science, philosophy, economics, sociology, psychology, business and industrial management, literature, history, biography, travel, and fine arts. Abstracts from this pamphlet have appeared in CIVIL ENGINEERING under the titles: "Helping the Young Engineer to Help Himself," page 279 of the May 1934 number; "Reading for Self-Improvement of Young Engineers," page 331 of the June 1934 number; and "Reading for Pleasure and Profit," page 664 of the December 1934 number.

The Committee on Professional Recognition is at work correlating the various grades of membership with the requirements for the licensing of engineers, and it is expected that during the coming year a plan will be developed that will considerably simplify the detailed work on this problem.

On the E.C.P.D., the Society is represented by Harrison P. Eddy, Past-President Am. Soc. C.E., and by J. Vipond Davies and J. P. H. Perry, Members Am. Soc. C.E. The chairman of the Executive Committee is Dr. C. F. Hirshfeld, of the Detroit Edison Company, and the Secretary is George T. Seabury, Secretary Am. Soc. C.E.

Pamphlet on Engineers' Liability

IN THE January issue, starting on page 48, appeared an article by W. W. Colpitts, M. Am. Soc. C.E., on "Liabilities of Engineers Under the Securities Act of 1933." In this article Mr. Colpitts abstracted for the benefit of his fellow engineers the significant features of the Securities Act of 1933 as amended by Title II of the Securities Exchange Act of 1934, and pointed out the necessity for extreme care on the part of engineers in making studies or valuations that are used as a basis for the issuance of most securities.

In order that this article might be available in convenient form for handling, for study, and for reference, it has been reprinted in a 6 by 9-in. size, so as to comprise a 16-page pamphlet in blue covers. As such, it is being placed in stock with Society publications and may be obtained upon request. A nominal price of 25 cents per copy has been set; in quantities of 100 or more the price will be 15 cents per copy.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of 222 National, State, and Local Engineering Societies Located in 41 States.

Better coordination of the existing system of engineering societies throughout the country was the keynote of the annual meeting of the American Engineering Council at the Mayflower Hotel in Washington, D.C., January 10, 11, and 12. Practical steps to this end included:

1. Provision for public affairs committees of the Council in each state, made up of key men from local societies and sections; and correlation of the Council's committees with the public affairs committees of member organizations.
2. A new membership plan to attract additional societies into the Council, thus making the central body more truly representative of the profession as a whole.
3. Increasing the 1935 budget of the Council by adding one-third more than last year's amount, thus enabling the "Washington Embassy" of engineers to render a more effective service.

It was recognized that, rather than set up new professional organizations, the thing to do is to use the ones already in existence, and to align them aggressively behind specific objectives such as engineering employment, increased participation in public affairs affecting the field of engineering development, and raising the prestige of the engineer in the public mind. Under the new plan, it is anticipated that the Council, the Engineers' Committee for Professional Development, the Engineering Foundation, the Society for the Promotion of Engineering Education, and the national, state and local engineering societies will carry these policies forward during the coming year.

Action before the Executive, Public Affairs, and other committees of the Council led to the adoption of the following resolutions by the assembly:

1. A new membership plan should be put into effect, embracing a flat-rate plan of nominal dues for local societies, whose delegates to Council meetings will pay their own expenses. The country will be divided into nine districts so that a group of societies in any district may jointly send a delegate to meetings at the expense of the Council. Under this arrangement delegates from individual societies may attend at the expense of their own societies. Adoption of this plan automatically brings into the Council the Engineers Club of Philadelphia and the Engineering Societies of New England, which voted previously to join, contingent on the adoption of the plan by the Council. At least a dozen other societies have announced their intention of joining.
2. The Public Affairs Committee should be divided into subcommittees, the chairmen of which are to be members of the main body and are to cooperate with similar committees of the engineering societies to facilitate joint action toward common objectives.
3. A Public Affairs Committee should be set up in each state—its members to be key men from local sections and societies—to provide an organization network for deliberation and action on public matters of moment to the profession.
4. Continued support should be given to the national mapping program.
5. Facts concerning rural electrification work, now scattered among several Federal agencies, should be pooled under the Bureau of Agricultural Engineering, together with data already collected by engineering groups throughout the country.
6. The conference of scretaries of member societies should be continued from time to time.
7. It is advocated that three bills before the past Congress be opposed, should they come up again. The bills, which had been considered by the Flood Control Committee of the Council, had to do with the development of the Arkansas River and tributaries. Such development was considered too large a job to be undertaken as a single project and to require further study as to feasibility. The TVA type of operation was thought too new an experiment to be extended until it has proved itself.

ELECTION OF OFFICERS AND SECRETARY'S REPORT

After the annual meeting had been called to order by President J. F. Coleman, Past-President Am. Soc. C.E., with a brief address of welcome, the assembly heard the annual report of Frederick M. Feiker, executive secretary of 13 years. Secretary Feiker told of the basic data assembled to show for the first time the distribution of engineers among the industries as well as the geographical spread of the profession by individuals and by societies. A summary of the distribution by societies is given in Table I. Through this work, it has been possible to interest the U. S. Bureau of Labor Statistics in the forthcoming survey of the engineering profession, which will show just how engineers have fared during the hard times and will give definite focus to future efforts toward raising professional standards. The Council staff also undertook a survey of engineering employment, present and prospective, among some 70 agencies of the Federal Government, indicating fields for placement of engineers as the President's work program takes form.

SYMPOSIUM ON FEDERAL WORK

Due to the importance of the Federal program in terms of engineering development, the principal focus of discussions was toward an interchange of ideas and information between the delegates and Federal officials in responsible charge of construction, planning, and other engineering functions of the Government. In effect, the meeting resulted in a symposium on the recovery program.

Ralph E. Flanders, president of the American Society of Mechanical Engineers, led the discussion on the outlook for the durable goods industries. R. E. W. Harrison, chief of the Machinery Division, U. S. Bureau of Foreign and Domestic Commerce, stressed the increased efficiency in railroad and merchant marine equipment as one of the steps toward recovery of these industries. He stated that modernization of U. S. Navy Yards is resulting in the replacement of machinery in use 25 to 30 years, during which time machine efficiency has trebled.

The session on planning and natural resources development was led by George W. McCuen, president of the American Society of Agricultural Engineers. The setting up of functional committees under the professional societies was advocated to develop data and technical standards for planning.

Dr. Isador Lubin, director of the U. S. Bureau of Labor Statistics, described progress on the survey of the engineering profession which his organization is about to make in cooperation with the Council and with engineering societies throughout the country. The survey and mapping program of the Federal Government was discussed by R. S. Patton, M. Am. Soc. C.E., Director of the U. S. Coast and Geodetic Survey, who pointed out that only half the nation has been mapped at all and only one-fourth adequately. The National Resources Board has reported to the President a $117,000,000 plan for completion of the map of the United States in ten years, employing 7,500 to 10,000 men, half of whom will be engineers.

Under the leadership of A. J. Hammond, Past-President of the American Society of Civil Engineers, construction trends were discussed in their Federal, private, and relief aspects. With a four-fifths drop in the construction industry during the depression, the construction worker is the real forgotten man. Donald H. Sawyer, M. Am. Soc. C.E., director of the Federal Employment Stabilization Office, and former PWA administrator, spoke on private construction, saying that the spirit of salesmanship must be revived in the industry without so much leaning upon the Federal Government. Thomas Hibben, chief engineer of the FERA, told of the development of work relief along lines of engineering construction with the twofold purpose of turning out socially useful work and enabling skilled men to retain their skill and their self-respect. Thousands of engineers have served in supervisory phases of the program. Clarence McDonough, M. Am. Soc. C.E., chief of the Engineering Division of the PWA, stressed the importance of the National Resources Board's findings in future development but made no predictions as to the future of the PWA while the President's new work program is yet pending. Charles C. Anthony, M. Am. Soc. C.E., industrial adviser for the Federal Housing Administration, urged engineers to "get behind" the housing program and to keep posted on its progress.

TABLE I. SUMMARY OF DISTRIBUTION OF ENGINEERING SOCIETIES

STATE	NATL. HQ.	LOCAL SECTIONS	STATE COUNCILS	STATE SOCIETIES	LOCAL COUNCILS	LOCAL SOCIETIES	REPRESENTED BY A.E.C.
Alabama	0	8	0	0	0	1	4
Arizona	0	6	0	0	0	0	1
Arkansas	0	1	0	1	0	3	1
California	0	37	0	0	2	15	9
Colorado	0	11	1	2	0	3	15
Connecticut	1	12	0	1	0	1	9
Delaware	0	1	0	0	0	0	0
District of Columbia	12	10	0	0	0	1	4
Florida	0	5	0	1	0	0	4
Georgia	0	6	0	0	0	1	4
Idaho	0	0	0	1	0	1	0
Illinois	12	23	0	2	0	10	7
Indiana	0	8	0	1	0	2	6
Iowa	0	4	0	1	0	2	3
Kansas	0	3	0	1	0	1	3
Kentucky	0	3	0	0	0	1	3
Louisiana	1	6	0	1	0	0	3
Maine	0	0	0	3	0	0	0
Maryland	0	7	0	0	0	2	3
Massachusetts	1	20	0	1	1	9	9
Michigan	4	16	1	0	0	14	7
Minnesota	0	10	0	2	0	5	6
Mississippi	0	2	0	0	0	0	1
Missouri	1	18	0	1	0	5	6
Montana	0	2	0	1	0	0	1
Nebraska	0	5	0	0	0	2	3
Nevada	0	1	0	0	0	0	0
New Hampshire	0	1	0	0	0	0	0
New Jersey	0	7	0	2	0	3	1
New Mexico	0	2	0	0	0	0	1
New York	36	38	0	3	0	21	24
North Carolina	0	7	1	0	0	2	4
North Dakota	0	0	0	1	0	0	0
Ohio	2	33	0	1	0	5	18
Oklahoma	1	10	0	0	0	1	3
Oregon	0	11	1	1	0	3	4
Pennsylvania	7	43	0	2	0	10	17
Rhode Island	0	4	0	0	0	1	3
South Carolina	1	2	0	2	0	1	1
South Dakota	0	0	0	2	0	0	0
Tennessee	0	8	0	1	0	4	7
Texas	0	15	0	1	0	5	7
Utah	0	7	1	2	0	1	3
Vermont	0	1	0	1	0	0	1
Virginia	1	4	0	0	0	2	3
Washington	0	18	0	2	0	4	7
West Virginia	0	4	0	0	0	0	1
Wisconsin	0	10	0	0	0	5	5
Wyoming	0	1	0	1	0	1	0
Totals	80	450	5	41	3	148	222

GOOD FELLOWSHIP DINNER

The Council dinner, preceded by an hour of good fellowship, proved to be one of the largest engineering functions ever held in Washington. More than 400 attended. The principal speaker was Dr. Harold G. Moulton, president of the Brookings Institution, which research organization has been making a detailed study of economic trends over the past 30 years. Under-consumption rather than over-capacity was indicated by Dr. Moulton's charts. In the boom years, capacity in most industries did not run far ahead of the demand for goods and services.

CONFERENCE OF SECRETARIES OF ENGINEERING SOCIETIES

A conference of some 40 secretaries of engineering societies—national, state, and local—was held during the first day and a half of the sessions of the Council, under the chairmanship of C. E. Sabin, secretary of the Cleveland Engineering Society. This was the largest meeting of its kind yet held. The first secretaries' conference met in 1923 with the Council meeting at Washington in that year, and the group assembled in other cities biennially thereafter until 1929. No meeting had been held since that year.

A Committee on Coordination of Engineering Organizations was set up by the conference to study the problem of overlapping dues and more effective joint action of the scattered societies. Representatives of two national, one state, and two local societies are on the committee.

A review of the relief activities of national and local societies showed how action developing spontaneously among engineering groups throughout the country has resulted in the raising of private funds and how the cooperation of public relief officials has resulted in providing cash or relief work for unemployed engineers. The Emergency Planning and Research Bureau of the Engineering Societies of New England, Boston, collected a private fund of $100,000 to employ engineers in compiling city records, planning activities, and other useful projects. In Cleveland, engineers operated a subsistence farm. Cleveland has the only full-time employment service, which is operated by a local society and cost $1,600 net for the year ending last June, and only $60 since June, because costs were offset by placement fees. It is expected that the service will be self-supporting this year. The work of the Professional Engineers' Committee on Unemployment, which raised over $200,000 and placed 5,500 engineers in New York and environs, was also described.

New types of service and activities for local organizations were discussed. An increased interest in employment and salaries was among the trends noted. In some cases, engineers on relief have been paid less than skilled labor, making it necessary for societies to negotiate with relief officials for a better pay scale. Discussion as to the interrelation of national and local activities resulted in the appointment of a continuing committee.

Washington, D.C.
January 15, 1935

Preview of Proceedings

Among the subjects to be treated in the February issue of PROCEEDINGS *are the following: the hydraulic jump in its application to open-channel flow and to the theory of dynamic similarity; frictional resistance in certain types of pipes; ratios of weights of metal in steel trusses to total vertical load; and the stabilization of masonry dams. The Annual Report of the Board of Direction will also be published in this number.*

THE HYDRAULIC JUMP IN TERMS OF DYNAMIC SIMILARITY

A KNOWLEDGE of the hydraulic jump is of considerable value in the study of the flow of water. In their forthcoming paper on "The Hydraulic Jump in Terms of Dynamic Similarity" Boris A. Bakhmeteff, M. Am. Soc. C.E., and Arthur E. Matzke, Jun. Am. Soc. C.E., have contributed notably to a more thorough understanding of this phenomenon in its application to open-channel flow and to the theory of dynamic similarity.

Hitherto, most of the research in this field has dealt with the "vertical" elements of the jump, such as the relationship between the lower and upper stages and the height of the standing wave. The "longitudinal" elements, such as the length of the jump and the profile of the surface of the roller, have scarcely been studied at all to date, and yet these characteristics are indispensable in designing stilling basins at the foot of spillways and in laying out devices to prevent erosion below sluices.

An interesting feature of the paper is that the principle of dynamic similarity is introduced in such a way that the final data are presented in terms of dimensionless ratios. The first objective sought in the research was to obtain comprehensive data concerning the length of the jump. A consistent plotting of the profiles was then undertaken, and the conclusions drawn from such profiles were interpreted in forms of the aforementioned ratios plotted against the kinetic flow factor previously introduced by Professor Bakhmeteff.

FRICTIONAL RESISTANCE IN ARTIFICIALLY ROUGHENED TYPES

THE TESTS described in a forthcoming paper by Victor L. Streeter, Jun. Am. Soc. C.E., were made in an effort to supply additional information concerning the problem of estimating friction losses in old pipes or in pipes roughened by use. He shows qualitatively the effect on the friction factor of certain artificial irregularities varying in shape and size that were introduced in pipes used for the test. The loss of head was measured in 2-in. brass pipes, the Reynolds numbers ranging from 20,000 to 1,250,000. The roughness element consisted of grooves cut spirally into the pipes, the degree of roughness being varied by changes in the depth, shape, and number of grooves per inch. Mr. Streeter found that the loss of head due to friction increased as the depth of grooves was increased, if the general shape of the grooves was maintained. If this shape was varied, however, it seemed to have a considerable effect on the loss of head. Furthermore, the loss of head was reduced when the number of grooves per inch was increased or, in other words, when the roughness elements were placed close together.

The paper is prefaced by a valuable review of previous investigations, including the presentation and explanation of the classical formulas applying to the flow of fluids in pipes. A fairly complete tabulation of experimental data and computed data is included in an appendix to the paper.

This paper was the basis of Mr. Streeter's thesis, presented to the University of Michigan, in partial fulfillment of the requirements for the degree of Doctor of Science.

RATIOS OF WEIGHTS OF METAL IN STEEL TRUSSES TO THE TOTAL VERTICAL LOAD FOR WHICH THEY ARE PROPORTIONED

IN THE forthcoming issue of PROCEEDINGS, it is planned that J. A. L. Waddell, M. Am. Soc. C.E., will present a paper on "Ratios of Weights of Metal in Steel Trusses to the Total Vertical Load for Which They Are Proportioned." Since the early eighties Dr. Waddell has been computing and recording bridge weights almost constantly. From this it might be concluded that to collate material for the present paper would be a relatively simple task. However, the task of preparing the paper proved laborious because, comparatively speaking, only a few of the available records of weights of metal could be used directly, the others being found by the manipulation of data according to certain principles that, at various times, have been established by Dr. Waddell.

The aim is to supply a bridge computer with diagrams for spans of any reasonable length and, for the usual types of structure, to determine the ratio of the weight of metal per linear foot in a truss to the total vertical load per linear foot for which that truss is to be designed, thus saving the computer considerable time and trouble. The curves are accompanied by adequate explanations and illustrative examples demonstrating their use in the ideal economic design. If a design that does not have an economic truss depth is to be checked, certain modifications may be made so that the curves presented in Dr. Waddell's paper can be used in any case.

STABILIZING CONSTRUCTED MASONRY DAMS BY MEANS OF CEMENT INJECTIONS

APPROXIMATELY 60 miles from Bombay, at an elevation of 2,200 ft above sea-level, there are three masonry dams that were constructed from 12 to 18 years ago for the purpose of impounding water for a hydro-electric development under a head of 1,700 ft. These three structures are called the Shirawta Dam, the Thokerwadi Dam, and the Wolwhan Dam. They are constructed of rubble masonry faced with ashlar, and in recent years water has been seeping through them in such increasingly serious volumes as to threaten their stability.

The paper by D. W. Cole, M. Am. Soc. C.E., scheduled for the February issue of PROCEEDINGS, is a clear, concise, and complete technical exposition of the field methods pursued in stopping the leaks and making these dams structurally safe. The plan of operation, the organization of personnel, the materials of construction,

SHIRAWTA DAM DURING A MONSOON SQUALL IN 1931

VIEW OF CHARACTERISTIC LEAK IN THE TOE OF SHIRAWTA DAM

the extent of borings, and costs are described in this paper in gratifying detail. The operations included core and percussion drilling and the injection of cement under varying degrees of pressure, depending upon the circumstances at a particular hole at a particular time.

Special problems arising from the use of unskilled native labor form an interesting phase of the paper. As a result of experience on one of these dams, the author has concluded: (1) that no benefits resulted from isolated grouting; (2) that toe holes appeared to be unnecessary and ineffectual for relief; and (3) that the only advantage of "stage injections" occurred when the leakage from the borings was so great that the pump could no longer deliver the grout to fill the hole and build up the pressure. The principal objective at all three dams was to make the structures as solid and stable as was practicable under the circumstances. The accompanying photographs show Shirawta Dam during a monsoon squall in 1931 and give a view of a characteristic leak in the toe of this structure.

ANNUAL REPORT OF THE BOARD OF DIRECTION

AS PRESENTED to the Annual Meeting on January 15, 1935, the full report of the Board of Direction concerning the Society's activities during 1934 and its financial status at the end of the year will be published in the February issue of PROCEEDINGS. High lights from the report have been abstracted and are presented elsewhere in these pages.

Getting Out Manual No. 10

ON DECEMBER 7, 1934, a copy of the Society's latest Manual, No. 10, "Technical Procedure for City Surveys," was placed in the mails. As stated in the foreward to this Manual, the text has been in preparation by the Committee on City Surveys of the Surveying and Mapping Division since the early part of 1928. As soon as the data could be put in mimeographed form, copies were widely circulated for review, comment, and correction by members of the Society, by universities, and by interested departments of the Government. A large amount of highly intellectual effort has been expended on the subject matter of this Manual by a large number of persons in addition to the members of the committee itself. After approval of the manuscript for publication, by the Board of Direction, the editorial department had the task of editing the text, preparing the illustrations and tables for the printer, carefully reading the proof, and supervising the printing itself.

But with all this, there remained the task of placing Manual No. 10 in the hands of all members of the Society. Early in December the printer deposited some 15,000 copies of the Manual, weighing all together over 4,000 lb, in the general office at Headquarters. Previously two members of the staff had spent a day and a half in running 15,000 envelopes through the addressograph machine, and another two days in sorting them into groups by states, cities, and foreign countries in accordance with Post Office rules and regulations.

The next step was to "stuff" the addressed envelopes, that is, place a copy of the Manual in each, a procedure requiring the time of three clerks for a whole week. When this operation was completed, the filled envelopes were placed in 80 standard mail bags, each of which was labeled for its destination. Then the bags were carried in hand trucks, via the freight elevator in the building to a waiting private truck for transportation to the General Post Office in New York City. Even when this large consignment of mail reached the Post Office the staff were not yet through with their part of the work. After the bags had been deposited on the postal scales and weighed by a postal clerk, the cash for the postage on the more than two tons of publications was paid. The domestic rate on this class of mail is 8 cents per lb, so that the total bill for postage alone amounted to $340. This laborious work on the part of certain members of the Headquarters staff was not obvious to the engineer as he glanced over his copy of the Manual, but it was nevertheless an important step in the placing of Manual No. 10 in his hands.

The procedure outlined for the mailing of Manual 10, is no unusual operation. With certain modifications in detail it is repeated whenever the membership is circularized with letters or publications. The only exceptions are in the case of PROCEEDINGS and CIVIL ENGINEERING, for which the "stuffing" and the mailing are done at the printers' establishments, although the envelopes are addressed and sorted at Society Headquarters.

A copy of Manual No. 10 was mailed to each member at his latest known address. If it was not received, an inquiry addressed to the Secretary will bring the Manual to the proper address.

News of Local Sections

ARIZONA SECTION

At the Annual Meeting of the Arizona Section, held on November 24, in Phoenix, Ariz., the following officers were elected for the coming year: E. S. Borgquist, president; William R. Hutchins, vice-president; and Jane H. Rider, secretary-treasurer. Joseph A. Fraps continues as a vice-president. A luncheon and entertainment followed the business session, and the afternoon was devoted to a technical meeting. A talk on "Soil Erosion Problem in Arizona" was given by B. P. Fleming, dean of engineering of New Mexico State College, and a paper by Frank W. Flittner was read. The final paper dealing with the topic, "Highway Bridges," was presented by Ralph A. Hoffman, bridge engineer in the Arizona State Highway Department. Stimulating discussion followed the reading of each paper, and the 43 members present enjoyed a very interesting meeting.

COLORADO SECTION

The Colorado Section held a meeting on November 12 at the Olin Hotel in Denver, Colo. At this session W. W. DeBerard, Western editor of the *Engineering News-Record*, described some of the engineering and construction features of the Fort Peck Dam. The speaker of the evening was I. J. McCrary, consultant of the Colorado State Planning Committee, who outlined some of the studies being made by the Colorado State Planning Board, which is working as a unit of the National Planning Board. There were 50 present at the dinner, and about 30 came in afterwards to hear the speakers.

On October 29 the Association of Junior Engineers held its second regular meeting. The speaker of the occasion was Professor Worcester of the University of Colorado, who discussed the geologic history and structure of Colorado.

On December 10 a meeting of the Colorado Section was held at the Olin Hotel in Denver. There was an attendance of 128 at the meeting, while 113 enjoyed the dinner preceding it. Among the speakers at the meeting were John B. Drisko, Traveling Fellow in Hydraulics from Massachusetts Institute of Technology, 1927–1929; Donald P. Barnes, Freeman Scholar from the Society, 1932–1933; and Samuel Shulits, Freeman Scholar from the Boston Society of Civil Engineers, 1928–1930. All three of these young men are connected with the Denver office of the U. S. Bureau of Reclamation. Another feature of interest was a talk on the history and aims of the Junior Association of the Colorado Section, which was given by William B. Huffine, of the U. S. Bureau of Public Roads.

CONNECTICUT SECTION

The Connecticut Section was entertained at New Haven on December 13 by the Yale University Student Chapter of the Society. Although this meeting was largely social in character, a description of the rowing tank in the gymnasium of the university was given by Donald F. Grant, a member of the Yale School of Engineering. After some interesting discussion on the subject, Mr. Grant demonstrated methods of coaching crews in the tanks. At the conclusion of this exhibition dinner was enjoyed by the 33 members and students present.

DAYTON SECTION

There were 24 present at a meeting of the Dayton Section held on December 17. The feature of the occasion was a talk by C. H. Eiffert, chief engineer of the Miami Conservancy District, whose

topic was "My Impressions of the Tennessee Valley Project." The annual election of officers, which was held at this time, resulted as follows: W. E. Keyser, president; Bernard T. Schad, second vice-president; and Charles H. Stephens, secretary-treasurer. W. R. Yount automatically becomes first vice-president.

DETROIT SECTION

At the annual meeting of the Detroit Section the following officers were elected for 1934–1935: R. H. Sherlock, president; M. R. Fisher, vice-president; W. C. Hirn, second vice-president; and R. L. McNamee, secretary-treasurer.

FLORIDA SECTION

At a meeting of the Florida Section held on October 20, the following officers were elected for the coming year: P. L. Reed, president, and D. S. Wallace, secretary-treasurer.

GEORGIA SECTION

On November 5 a luncheon meeting of the Georgia Section was held in Atlanta, with 115 present. Sherman M. Woodward, consulting engineer for the Tennessee Valley Authority, gave an interesting description of certain aspects of construction of Norris Dam. Included in the business session of the meeting of the Section held on December 10 was the election of officers for 1935. Results of this election were as follows: R. P. Black, president; M. T. Singleton, vice-president; Schley Gordy, non-resident vice-president; and L. F. Bellinger, secretary-treasurer.

ITHACA SECTION

The first Engineers' Day of the Ithaca Section was held on November 17, the program consisting of a technical session in the morning and a dinner meeting in the evening. The afternoon was left open for the convenience of those who desired to attend the Cornell-Dartmouth football game. At the technical session various hydraulic problems were discussed, and Carl C. Cooman, of the Rochester Gas and Electric Corporation, displayed motion pictures of hydraulic studies. There were 55 present at the dinner meeting in the evening, which was held in Willard Straight Hall on the campus of Cornell University.

KANSAS CITY SECTION

A meeting of the Kansas City Section was held in Kansas City, Mo., on December 13, with 26 members present. A talk on the construction of the new municipal convention hall and auditorium was given by M. S. Murray, Director of Public Works of Kansas City. The result of the annual election of officers, which took place at this session, was as follows: O. A. Zimmerman, president; R. P. Woods, first vice-president; T. D. Samuel, Jr., second vice-president; and A. B. Taylor, secretary-treasurer.

LOS ANGELES SECTION

A dinner meeting of the Los Angeles Section, which was held on January 9, attracted an attendance of 251. After dinner several speakers were heard, including Gordon Whitnall and R. M. Langer, who described various features of the construction and functioning of the planetarium now approaching completion at the California Institute of Technology. The meeting was concluded at the planetarium, where interesting demonstrations of the operations of equipment were given. At the December meeting of the Section officers for 1935 were elected as follows: Alfred Jones, president; Ralph W. Lawton and Oliver G. Bowen, vice-presidents; D. A. Lane, secretary; and John C. Albers, treasurer.

MARYLAND SECTION

At a meeting of the Maryland Section, held on December 6 at the Engineers Club in Baltimore, the following officers were elected for the ensuing year: James W. Armstrong, president; P. G. Lang, vice-president; and C. B. Bryant, secretary-treasurer.

METROPOLITAN SECTION

At the regular monthly meeting of the Metropolitan Section, held in the Engineering Societies Building in New York on December 19, there was an enlightening discussion on the subject of construction codes. This discussion took the form of a symposium introduced by Willard T. Chevalier, publicity director of the McGraw-Hill Publishing Company, who recounted the origin of the NIRA and the development of its code for the construction industry, emphasizing the outstanding problems of the moment. Then William Arthur Payne spoke on some of the difficulties confronting the general contractor. Finally Stephen F. Voorhees, an architect of New York, N.Y., speaking as chairman of the National Code Authority for the Construction Industry, gave a most illuminating review of his official activities, disclosing the positive accomplishments, the barriers encountered, and the ideals in view. About 175 members and guests enjoyed this program, and refreshments were served as usual at the close of the meeting.

There were about 400 in attendance at a regular meeting of the Section held on January 9. The general topic at this session was "Photography—Absorbing Hobby and Technical Aid," which was covered by two interesting speakers: Adolph Fassbender, Fellow of the Royal Photographic Society (Great Britain) and head of the Department of Photography of the Brooklyn Institute of Arts and Sciences, and Joseph L. Boon, of the Eastman Kodak Company, who explained various aspects of the subject. An extensive discussion followed, after which refreshments were served.

MILWAUKEE SECTION

The Milwaukee Section held a meeting on October 11 at the City Club. The speakers of the evening were Eugene Howard, supervising engineer of the Milwaukee County Regional Planning Department, and Victor J. Brown, in charge of the Sheridan Park CCC camp. Both addressed the audience on the work being done in the camps under their direction. Another meeting of the Section, in conjunction with a session of the Marquette University Student Chapter, took place on November 15, at the Stratford Arms Hotel. This gathering was addressed by Frank Coleman, meteorologist of the Milwaukee office of the U. S. Weather Bureau, who spoke on the organization of the weather bureau and the basic movement of air currents about the earth.

NORTHWESTERN SECTION

About 60 members attended the meeting of the Northwestern Section held on November 22, at which Luther S. Oakes, president of Winston Brothers Company, gave an illustrated talk on "The Construction of the Morris Dam and the Columbia River Jetty." At this session the following officers were elected for the coming year: Hibbert M. Hill, president; O. M. Leland, first vice-president; Henry Dougan, second vice-president; and Lorenz G. Straub, secretary-treasurer.

PANAMA SECTION

At the annual meeting of the Panama Section held on December 10, Gen. Lytle Brown, formerly Chief of Engineers of the U. S. Army, gave an interesting address on the subject, "River and Harbor Work in the United States." After the address, the result of the election of officers for 1935 was announced as follows: L. B. Moore, president; H. G. Arango, first vice-president; R. C. Jones, second vice-president; and E. M. Browder, Jr., secretary-treasurer.

PORTLAND (ORE.) SECTION

A meeting of the Portland (Ore.) Section held on December 18 was devoted largely to consideration of the topic, "Phases of Design and Construction of the Bonneville Project." A general résumé of the subject, presented by C. I. Grimm, chief engineer of the project, was followed by detailed descriptions of different aspects of the project. These talks were illustrated by lantern slides and proved very interesting. The attendance numbered about 100.

ST. LOUIS SECTION

At a recent meeting of the St. Louis Section the following officers were elected for 1935: H. Austill, president; S. C. Baker and J. H. Porter, vice-presidents; and R. A. Willis, secretary-treasurer.

SOUTH CAROLINA

On November 2 the South Carolina Section held a meeting in Columbia, at which G. L. Reed, president of the Georgia Section, was the guest speaker. The meeting, which was held jointly with a session of the South Carolina Society of Engineers, was a pleasurable occasion for all.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for March

BECAUSE of the number and scope of the papers presented at the Annual Meeting of the Society in New York in January 1935, these papers are to be divided into two parts for publication in CIVIL ENGINEERING. By so dividing them both the March and the April issue will be devoted exclusively to abstracts of Meeting papers, and a somewhat more generous amount of space may be devoted to each article.

The group of papers selected for abstracting in the March issue includes the Society committee reports; a symposium on the power developments now under construction by the Tennessee Valley Authority; and a symposium on highway design from the viewpoint of speed and safety. An article on city planning with reference to slum elimination and another stressing the necessity for continuing planning during periods of depression are to be included. There will also be a brief abstract of a paper on the Cape Cod Canal and another on the extent of damage to wood piling in New England waters by marine borers. Two of the papers presented before the Sanitary Engineering Division have been selected for the March issue, one dealing with the removal of grease and oil from sewage and another on the present status and possibilities of the chemical treatment of sewage. From the Structural Division program the report of the Division's Committee on Masonry and Reinforced Concrete Arches has been selected for March publication together with a paper discussing the pressure of concrete on forms.

In the April issue the remaining papers will be abstracted and presented. Among them will be the reports of five committees of the Sanitary Engineering Division in addition to three symposiums: one on common sense in structural design, another on water-measuring devices, and a third on state planning boards. Thus the next two issues of CIVIL ENGINEERING will include abstracts of all the Annual Meeting papers.

Washington Award Goes to Ambrose Swasey

ANNOUNCEMENT has been made that Ambrose Swasey, Hon. M. Am. Soc. C.E., has been selected to receive the Washington Award for the year 1935. This award is administered by the Western Society of Engineers, and the recipient is chosen annually by a Commission of Award, composed of nine members of the Western Society of Engineers and two members each of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. Formal presentation will take place just before Washington's birthday, on February 20, 1935, at a joint meeting of members of the societies represented on the commission.

The award, founded in 1915 by John W. Alvord, M. Am. Soc. C.E., takes the form of a bronze medal or other work of art "as an honor conferred upon a brother engineer by his fellow engineers on account of accomplishments which preeminently promote the happiness, comfort, and well-being of humanity."

Tower for Study of Plumbing Equipment

NOT the least of the difficulties encountered in the design and maintenance of a high building lies in the plumbing facilities: forcing fresh water to the upper floors and returning the waste to the city sewers. To decrease the amount of guesswork used in proportioning a piping system for this purpose, the National Bureau of Standards has erected, in Washington, D.C., a tower 100 ft high and 12 ft square, representing a 10-story building surmounted by a tank of 3,000-gal capacity. Each floor contains various combinations of plumbing equipment.

TOWER REPRESENTING A 10-STORY BUILDING

For the Study of Plumbing Equipment and Pipe Sizes

The basic data and experience records of the experimental work with this tower, are to be made available in a report as soon as actual practice in high buildings has proved the results of these experiments. It is believed that a reduction in the cost of the plumbing in high buildings will result from the smaller pipe sizes made possible by the bureau's investigations.

Research Projects and Organizations Aided by the Engineering Foundation

PROPOSALS RECEIVED from the four Founder Societies and other applicants for aid in research during 1935 have been examined and considered by the Research Procedure Committee of The Engineering Foundation. A tentative program of projects and of organizations directly or indirectly in the civil engineering field, to be aided by the Foundation during the year, has been approved as follows:

PROJECTS:

- Earths and foundations
- Concrete and reinforced concrete arches
- Alloys of iron
- Effects of temperature on properties of metals
- Wire rope
- Riveted joints
- Fluid meters
- Pure iron electrodes for welding (Lehigh University)
- Critical review of welding literature

ORGANIZATIONS:

Engineers' Council for Professional Development:

1. Evaluating guidance literature
2. Self-appraisal methods
3. Evaluating professional qualifications
4. Research publication
5. Accrediting schools
6. Aptitude tests
7. Developmental expense for preliminary period

Personnel Research Federation:

Development of conference methods

University of California:

Plastic flow of concrete

University of Pittsburgh:

Plasticity of metals

Among the activities of the Engineering Foundation is the issuing of a series of books entitled "Alloys of Iron Research." The fourth book in this series, *The Alloys of Iron and Copper*, has just been published. The preceding three books, in the order of their publication, are: (1) *The Alloys of Iron and Molybdenum*, of which the second printing has been ordered; (2) *The Alloys of Iron and Silicon;* and (3) *The Alloys of Iron and Tungsten*. Copies of them may be ordered by addressing The Engineering Foundation, 29 West 39th Street, New York, N.Y. The first and third volumes in the series are $6 and the other two are $5.

The National Mapping Plan

Of the Board of Surveys and Maps of the Federal Government

BY executive order, on June 30, 1934, the President of the United States established the National Resources Board as the successor to the National Planning Board and the Committee on National Land Problems. The Board thus formed was directed to report to the President on the land and water resources of the United States. Its report, now in the hands of the President, is the first attempt in the nation's history to make an inventory of the country's assets and of the problems relating to them. As presented, the report is divided into five major parts: first, the recommendations of the Board itself; second, the report of its Land Planning Committee; third, the report of its Water Planning Committee; fourth, the report of the Planning Committee for Mineral Policy; and fifth, the report of the Board of Surveys and Maps. Of significant importance to the civil engineer is the report of the Board of Surveys and Maps, which is reproduced here in full except for two charts showing the status of the topographic mapping of the United States and the proposed plan for its completion in terms of priority.

The member organizations of the Board of Surveys and Maps consist of the following: the Corps of Engineers (W. Dept.), Coast and Geodetic Survey (C. Dept.), Geological Survey (I. Dept.), General Land Office (I. Dept.), Division of Topography (P. O. Dept.), Bureau of Soils (A. Dept.), Bureau of Reclamation (I. Dept.), Bureau of Public Roads (A. Dept.), Office of Indian Affairs (I. Dept.), Mississippi River Comm. (W. Dept.), Lake Survey (W. Dept.), International (Canada) Bdy. Comm. (S. Dept.), Forest Service (A. Dept.), Hydrographic Office (N. Dept.), M.I.D., General Staff (W. Dept.), Federal Power Commission, Air Corps (W. Dept.), Bureau of Aeronautics (N. Dept.), Aeronautics Branch (C. Dept.), Bureau of For. and Domes. Com. (C. Dept.), Geographic Section (S. Dept.), Division of Maps (Library of Congress), and Bureau of Lighthouses.

1. Most of the land planning and land use agencies of the Federal Government, as well as many other Federal and State organizations whose activities are concerned with land, have asked the Board of Surveys and Maps to prepare a program for the completion at an early date of the mapping of the United States. The Board has made an exhaustive investigation and finds much evidence that the actual loss of money due to lack of adequate maps is greater than the estimated cost of completion of the standard map of the United States. Moreover, most of the land-use agencies have testified that the absence of adequate map data makes it almost impossible to carry out any plan of readjustment in land use until the areas affected are adequately mapped.

2. Of the 3,050,000 sq miles contained in the continental United States, exclusive of Alaska, only about 810,000 sq miles (26 per cent) have been covered by adequate topographic maps, about 740,000 sq miles (24 per cent were mapped over 40 years ago by methods and on scales inadequate for present day needs, and about 1,500,000 sq miles (50 per cent) of the entire area) remain entirely unmapped.

3. The Board has prepared a program which, if adopted and carried out, will provide for the completion in ten years of the standard surveying and mapping of the United States, and in two years of all essential areas needed for immediate planning purposes by Federal agencies.

4. *Plan*

a. The plan adopted by the Board of Surveys and Maps of the Federal Government at its executive meeting on October 22, 1934, is as follows:

(1) The compilation of planimetric base maps from aerial photographs taken on a scale of about 1:20,000 of all of the unmapped or inadequately mapped agricultural lands in the eastern and southern states where the boundaries of farms and fields are irregular in shape, and most fields are relatively small, and of other areas of extreme economic importance, estimated to cover in all about 300,000 sq miles; the publication of preliminary sheets without contours on a scale of 1:24,000; and the preparation of contour maps as soon as practicable after the planimetric maps are available and the publication of the results in advance sheet form on the scale of 1:31,680 and in final form on a scale of 1:62,500.

(2) The compilation of planimetric base maps from aerial photographs taken on a scale of about 1:31,680 of all of the unmapped or inadequately mapped agricultural lands in states where individual farms and fields are relatively large and regular in shape, and of other areas of moderate economic importance, estimated to cover in all about 1,216,000 sq miles; the publication of preliminary sheets without contours on the scale of 1:31,680; and the preparation of contour maps as soon as practicable after the planimetric maps are available and the publication of the results in advance sheet form on the scale of 1:48,000 (4,000 ft to the inch) and in final form on the scale of 1:62,500.

(3) The compilation of base sheets by adequate use of aerial photography of all other unmapped or inadequately mapped areas of minor economic importance, such as rugged mountains and sparsely settled deserts, estimated to cover about 700,000 sq miles; no preliminary sheets without contours to be published but contours to be added as soon as practicable after the base sheets are prepared. The results to be published in advance sheet form on the scale of 1:96,000 (8,000 ft to the inch) and in final form on the scale of 1:125,000 (approximately 2 miles to the inch).

b. The Board recommends showing on all preliminary sheets under (1) and (2) all fences and other property lines that can be identified on the photographs. Aerial photographs can be enlarged accurately to double scale and the base maps can be enlarged photographically to meet most of the needs of the various land use or land planning agencies.

c. The foregoing meets the requirements submitted by the various map-using agencies, with the exception of a few cases in which larger scales may be required. In the event that any agency, or agencies, need planimetric or contour maps on larger scales, involving additional field and office work, funds in addition to those recommended below will be required.

5. *Priority of Areas*

a. The Board tabulated graphically on a base map of the United States the mapped areas of continental United States exclusive of Alaska, showing thereon approximately 810,000 sq miles covered by adequate maps, and approximately 739,300 sq miles covered by inadequate maps needing resurveys, leaving about 1,476,600 sq miles of unmapped territory.

b. The Board also tabulated graphically on a similar base map the unmapped and inadequately mapped areas, and recommends dividing them into three tentative priority groups (the first to be completed in two years, the second in the next three years, and the third in the last five years), with most of the inadequately mapped areas placed in the last group. These priorities are based on present requirements submitted by the various map-using agencies, but they must be subject to modification to meet changing needs.

6. *Estimates for Aerial Photography*

The Board found the amount of aerial photographs available for adequate map work in unmapped or inadequately mapped areas to cover about 100,000 sq miles. Additional aerial photographs will be required to cover about 2,000,000 sq miles, at an average cost of $2.50 per sq mile or a total of $5,340,000. It is doubtful that commercial aerial photographers will be willing to equip themselves with multiple-lens cameras suitable for a large part of the map work unless they can be assured in advance of work that will justify the expenditure. It is recommended, therefore, that the Federal air services cooperate in the aerial photography until civilian aerial photographers can meet the needs of the mapping agencies, or else that funds be made available to the Federal mapping agencies to purchase suitable mapping cameras to be furnished under bond to civilian photographers. Full use should be made of stereoscopic plotting instruments for mak-

TABLE I. SHOWING DETAILS OF NATIONAL MAPPING PROGRAM

PRIORITY	YEAR	ITEM	AREA IN SQUARE MILES: Hor. Control	Vert. Control	Aerial Photos	Plan Maps	Contour Maps	Reproduction	ESTIMATED COST: Hor. Control	Vert. Control	Aerial Photos	Plan Maps	Contour Maps	Reproduction	TOTAL
First	1	Equip.							500,000	200,000	200,000	10,000	290,000		1,200,000
	1	1st Ord. Triang.							1,800,000						1,800,000
	1	(1)	116,000	116,000	116,000	116,000	58,000	58,000	696,000	145,000	348,000	1,508,000	3,306,000	493,000	6,496,000
	1	(2)	186,000	126,000	186,000	114,000	62,000	62,000	1,116,000	157,500	465,000	1,254,000	1,674,000	419,000	5,085,500
	1	(3)	33,000	38,000	33,000	20,000	16 000	16,000	198,000	47,500	66,000	120,000	240,000	23,000	694,500
	1	Total	335,000	280,000	335,000	250,000	136,000	136,000	4,310,000	550,000	1,079,000	2,892,000	5,510,000	935,000	15,276,000
	2	1st Ord. Triang.							1,700,000						1,700,000
	2	(1)	50,000	50,000	50,000	50,000	58,000	58,000	300,000	62,500	150,000	650,000	3,306,000	361,000	4,829,500
	2	(2)	225,000	170,000	225,000	210,000	63,500	63,500	1,350,000	212,500	562,500	2,310,000	1,714,500	569,000	6,718,500
	2	(3)	60,000	60,000	60,000	40,000	16,300	16 300	360,000	75,000	120,000	240,000	244,500	30,300	1,069,800
	2	Total	335,000	280,000	335,000	300,000	137,800	137,800	3,710,000	350,000	832,500	3,200,000	5,265,000	960,300	14,317,800
First	1&2	Total	670,000	560,000	670,000	550,000	273,800	273,800	8,020,000	900,000	1,911,500	6,092,000	10,775,000	1,895,300	29,593,800
Second	3	(1)	50,000	50,000	50,000	50,000	48,800	48,800	300,000	62,500	150,000	650,000	2,781,600	319,600	4,263,700
	3	(2)	300,000	180,000	250,000	260,000	122,700	122,700	1,800,000	225,000	625,000	2,860,000	3,312,900	880,800	9,703,700
	3	(3)	50,000	50,000	35,000	40,000	28,700	28,700	300,000	62,500	70,000	240,000	430,500	42,700	1,145,700
	3	Total	400,000	280,000	335,000	350,000	200,200	200,200	2,400,000	350,000	845,000	3,750,000	6,525,000	1,243,100	15,113,100
	4	(1)	50,000	50,000	50,000	50,000	48,700	48,700	300,000	62,500	150,000	650,000	2,775,900	319,150	4,257,550
	4	(2)	300,000	180,000	250,000	260,000	122,700	122,700	1,800,000	225,000	625,000	2,860,000	3,312,900	880,800	9,703,700
	4	(3)	50,000	50,000	35,000	40,000	28,700	28,700	300,000	62,500	70,000	240,000	430,500	42,700	1,145,700
	4	Total	400,000	280,000	335,000	350,000	200,100	200,100	2,400,000	350,000	845,000	3,750,000	6,519,300	1,242,650	15,106,950
	5	(1)	34,000	34,000	34,000	34,000	48,700	48,700	204,000	42,500	102,000	442,000	2,775,900	287,150	3,853,550
	5	(2)	200,000	180,000	250,000	260,000	122,700	122,700	1,200,000	225,000	625,000	2,860,000	3,312,900	880,800	9,103,700
	5	(3)	150,000	66,000	51,000	40,000	28,800	28,800	900,000	82,500	102,000	240,000	432,000	42,800	1,799,300
	5	Total	384,000	280,000	335,000	334,000	200,200	200,200	2,304,000	350,000	829,000	3,542,000	6,520,800	1,210,750	14,756,550
Second	3-4-5	Total	1,184,000	840,000	1,005,000	1,034,000	600,500	600,500	7,104,000	1,050,000	2,519,000	11,042,000	19,565,100	3,696,500	44,976,600
Third	6	(1)	.....	.....	.....	.....	20,000	20,000	.....	.....	.....	.....	1,140,000	90,000	1,230,000
	6	(2)	5,000	140,000	55,000	62,000	120,000	120,000	30,000	175,000	137,500	682,000	3,240,000	573,000	4,837,500
	6	(3)	357,000	140,000	270,000	238,000	125,000	125,000	2,142,000	175,000	540,000	1,428,000	1,875,000	208,300	6,368,300
	6	Total	362,000	280,000	325,000	300,000	265,000	325,000	2,172,000	350,000	677,500	2,110,000	6,255,000	871,300	12,435,800
	7	(1)	.....	.....	.....	.....	17,800	17,800	.....	.....	.....	.....	1,014,600	80,100	1,094,700
	7	(2)	.....	140,000	.....	50,000	150,000	150,000	.....	175,000	.....	550,000	4,050,000	675,000	5,450,000
	7	(3)	.....	140,000	216,000	166,000	157,200	157,200	.....	175,000	432,000	996,000	2,358,000	215,300	4,176,300
	7	Total	.....	280,000	216,000	216,000	325,000	325,000	.....	350,000	432,000	1,546,000	7,422,600	970,400	10,721,000
	8	(1)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	8	(2)	.....	100,000	.....	.....	150,000	150,000	.....	125,000	.....	.....	4,050,000	600,000	4,775,000
	8	(3)	.....	156,000	.....	116,000	150,000	150,000	.....	129,000	.....	696,000	2,250,000	190,600	3,265,600
	8	Total	.....	256,000	.....	116,000	300,000	300,000	.....	254,000	.....	696,000	6,300,000	790,600	8,040,600
	9	(1)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	9	(2)	.....	.....	.....	.....	160,000	160,000	.....	.....	.....	.....	4,320,000	640,000	4,960,000
	9	(3)	.....	.....	.....	.....	110,000	110,000	.....	.....	.....	.....	1,650,000	110,000	1,760,000
	9	Total	.....	.....	.....	.....	270,000	270,000	.....	.....	.....	.....	5,970,000	750,000	6,720,000
	10	(1)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	10	(2)	.....	.....	.....	.....	142,400	142,400	.....	.....	.....	.....	3,844,800	569,600	4,414,400
	10	(3)	.....	.....	.....	.....	39,300	39,300	.....	.....	.....	.....	589,500	39,300	628,800
	10	Total	.....	.....	.....	.....	181,700	181,700	.....	.....	.....	.....	4,434,300	608,900	5,043,200
Third	6-10	Total	362,000	816,000	541,000	632,000	1,341,700	1,341,700	2,172,000	954,000	1,109,500	4,352,000	30,381,900	3,991,200	42,960,600
Grand total...			2,216,000	2,216,000	2,216,000	2,216,000	2,216,000	2,216,000	17,296,000	2,904,000	5,540,000	21,486,000	60,722,000	9,583,000	117,531,000

NOTE: Reproduction items are included in same year as contour map items, but they may lag from 6 months to 1 year behind contour mapping.

ing contour maps, especially in all areas which are not too heavily timbered and which are to be mapped with a contour interval of 20 ft or larger. The Board recommends that at least $200,000 be made available for the purchase of mapping cameras and stereoscopic plotting instruments, making a total of $5,540,000 for aerial photography.

7. *Estimates for Control Surveys*

The Board investigated the amount of horizontal and vertical control available and estimated the amount required to complete the mapping program. It recommends the completion of the 25-mile spacing of first- and second-order arcs of triangulation at an estimated cost of $3,500,000, and the extension of supplemental horizontal and vertical control surveys designed to provide the required number of additional points on each map sheet, at an estimated cost of $16,000,000. This, with an estimated requirement of $700,000 for instruments, trucks, and towers, will completely control the area of continental United States exclusive of Alaska for the purposes of this mapping program at a total cost of $20,200,000.

8. *Estimates of Mapping Costs*

The Board investigated the cost of each item in the planimetric and contour-map program and submits the following estimates of average cost, exclusive of control surveys, aerial photography, and map reproduction, under each of the three classifications given above:

(1) Planimetric maps, 300,000 sq miles at $13 per sq mile . . . $3,900,000
Contour maps, 300,000 sq miles at $57 per sq mile . . . 17,100,000
(2) Planimetric maps, 1,216,000 sq miles at $11 per sq mile. . . . 13,376,000
Contour maps, 1,216,000 sq miles at $27 per sq mile. . . . 32,832,000
(3) Base maps, 700,000 sq miles at $6 per sq mile 4,200,000
Contour maps, 700,000 sq miles at $15 per sq mile 10,500,000

9. *Property Maps and Mosaics*

The Board feels that the making of ownership maps or mosaics, showing individual farms and other tracts of land with their acreage and the names of the owners, should not be a part of the primary mapping program but should be carried on by states, counties, or Federal agencies after the base maps have been prepared. The Board believes that these agencies could plot ownership data on individual aerial photographs, which offer the best means of acquiring the data, because the owner can see a picture of his farm and adjoining land owners can usually indicate to the surveyor an acceptable line between two farms. The acreage of each farm or field can then be scaled or measured with a planimeter and the data transferred to the base map or to a mosaic made from ratioed prints of the same

photographs used in making the base map and in acquiring the ownership data. The legal reestablishment of property lines is a very expensive procedure and cannot be a part of the primary mapping program.

10. *Estimates for Map Reproduction*

a. The Board investigated the methods and the cost of reproduction of adequate editions of maps prepared under the three classifications given above and recommends four-color reproduction of planimetric sheets, one-color reproduction of advance sheets of contour maps, and five-color reproduction of final contour sheets, with all of the reproduction by photolithography, except possibly the most intricate final contour maps, which should be printed from plates made by copper plate or glass engraving.

b. The estimates of cost for map reproduction are as follows:

(1)	Planimetric maps, 300,000 sq miles at $2.00 per sq mile. .	$ 600,000
	Advance contour sheets, 300,000 sq miles at $1.00 per sq mile.	300,000
	Final contour maps, 300,000 sq miles at $3.50 per sq mile. . .	1,050,000
(2)	Planimetric maps, 1,216,000 sq miles at $1.50 per sq mile. . .	1,824,000
	Advance contour sheets, 1,216,000 sq miles at $0.50 per sq mile.	608,000
	Final contour maps, 1,216,000 sq miles at $3.50 per sq mile. . .	4,256,000
(3)	Advance contour sheets, 700,000 sq miles at $0.35 per sq mile.	245,000
	Final contour maps, 700,000 sq miles at $1.00 per sq mile. . .	700,000

11. *Total estimated Cost*

a. The total estimated cost of completion of the mapping of the United States according to the above schedule, including the resurvey of inadequately mapped areas, and the purchase of additional instruments and trucks, but excluding the making of property maps or mosaics, is tabulated as follows:

Control surveys	$ 20,200,000
Aerial photography. . . .	5,540,000
Planimetric mapping . . .	21,486,000
Contour mapping	60,722,000
Reproduction	9,583,000
Total.	$117,531,000

b. The total area to be mapped involves about 2,200,000 sq miles, so that the average cost involves an expenditure of about $54 per sq mile, or about 8 cents per acre.

12. *Program*

a. In view of the urgent need of maps by all Federal planning and land use agencies at the present time the Board has provided a program which contemplates completing all of the mapping of areas requested by these agencies in two years. When the magnitude of the project and its wide dissemination in all parts of the country is considered, an orderly and efficient prosecution of the work will not permit reducing this estimate. The whole program is planned for completion in a period of 10 years, in which the horizontal control will be finished in 6 years, the planimetric mapping in 7 years, the vertical control in 8 years, and the final contouring in 10 years. The different elements of such a program should be coordinated so that they will proceed in a logical manner and contour mapping will proceed as soon as the planimetric base maps are prepared.

b. The Board recommends that funds be made available in accordance with the following table, based on the detailed estimates shown in Table I:

First year	$ 15,000,000
Second year	15,000,000
Third year	15,000,000
Fourth year	15,000,000
Fifth year.	15,000,000
Sixth year	12,000,000
Seventh year	10,000,000
Eighth year	8,000,000
Ninth year.	7,000,000
Tenth year	5,531,000
Total.	$117,531,000

13. *Federal Interest*

The Board recommends that the program be 100 per cent Federal, and that it be financed from Federal funds, except that where state or civic subdivisions desire larger scale maps than are now included in the program, such agencies will bear the additional cost thereof.

14. *Agencies Available to Carry Out Program*

The Federal Government now maintains in the U. S. Geological Survey and the U.S. Coast and Geodetic Survey basic mapping agencies entirely competent to carry out the Board's program. The Board recommends that funds necessary for control, and equipment pertaining thereto, in this program be made available to the U. S. Coast and Geodetic Survey, and that all other funds be made available for use by the U. S. Geological Survey.

For the Board:

F. B. WILBY, *Lieutenant Colonel, Corps of Engineers, Chairman of the Board*

Washington, D.C.
November 13, 1934

National Resources Board Reports

BROAD OUTLINES of a program of long-range planning by which the natural resources of the nation will be conserved and utilized for the benefit of all, now and in the future, are stated in the report of the National Resources Board dated December 1, 1934, and submitted to the President of the United States. The principal recommendation of the board is the development of a permanent agency to plan for the nation on a scientific basis and with an understanding of all the elements involved in the problem.

According to the board's report, as the program is carried through it may be expected to:

"1. Provide for the systematic development of our water resources for purposes of sanitation, power, industrial uses, transportation, recreation, domestic consumption, and other collateral uses on a far higher level than ever before.

"2. Remove the recurring menace of great floods and vast losses to persons and property.

"3. End the heavy losses of soil caused by uncontrolled erosion.

"4. Eliminate the use of land incapable of affording a minimum standard of living, develop agricultural production on the most suitable soils only, and aid in raising the standards of living in many agricultural regions.

"5. End the wasteful use of our mineral resources and substitute a national policy of mineral conservation.

"6. Make available large areas of land for purposes of popular recreation.

"7. Assemble basic data in regard to mapping, public finance, and population, necessary for national planning.

"8. Avoid the extravagance caused by failure to coordinate public works—Federal, state, and local; bring about better programming of socially useful public works; prepare public works projects suitable, if desired, for use in emergency situations.

"9. Provide for continuous long-range planning of land, water, and mineral resources in relation to each other and to the larger background of the social and economic life in which they are set."

Commenting on these findings, the board states:

"It is, of course, idle to expect that the mere declaration of a set of policies will automatically produce such results. Legislation, administration, cooperation of many different types of government on many levels, and strongly supporting public opinion—all are necessary to bring about substantial changes of the kind just indicated. Nor can it be forgotten that the use of natural resources is not a thing apart, but involved closely in the whole mass of human activities, with industry, labor, finance, taxation. Natural resources planning is not planning at all if it leaves out of account the many vital factors in our economic and social life, the resultant of which makes a standard of living.

"It is the judgment of your board, however, that the broad policies here outlined, would, if put into practical execution, with the hearty and continuing support of the Government and the people of the nation, lead to very substantial gains in the nation's wealth and in the broad distribution of human welfare at which our national policy aims."

In addition to the findings and recommendations of the board, Part I, the report includes detailed reports from its Land Planning Committee, Part II; its Water Planning Committee, Part III; its Planning Committee for Mineral Policy, Part IV; and its Board of Surveys and Maps, Part V. Elsewhere in this issue the report of the Board of Surveys and Maps, Part V, is printed in full. On December 1, 1934, Part I was sent to the

President, and since that time other parts have been forwarded to him and their contents made public as completed.

At the head of the National Resources Board is the Secretary of the Interior, Harold L. Ickes, as chairman; and the personnel consists of George H. Dern, Secretary of War; Henry A. Wallace, Secretary of Agriculture; Daniel C. Roper, Secretary of Commerce; Frances Perkins, Secretary of Labor; and Harry L. Hopkins, Federal Emergency Relief Administrator. There is also a civilian advisory committee consisting of Frederic C. Delano, Charles E. Merriam, and Wesley C. Mitchell, who are also members of the board. On the staff are Dr. L. C. Gray, director of the Land Section, and Morris L. Cooke, director of the Water Section and chairman of the Water Planning Committee.

The Water Planning Committee is the same as the Mississippi Valley Committee of the PWA, whose comprehensive report on the flood control, low-water control, navigation, power, water supply, sanitation, and erosion in the great central valley was presented to Harold L. Ickes, Administrator, on October 1, 1934. This report is now on file in the Society's Reading Room. The personnel of the Water Planning Committee is as follows: Mr. Cooke, chairman; H. H. Barrows; H. S. Persons; H. S. Crocker, Past-President Am. Soc. C.E.; G. E. Edgerton, C. H. Paul, and S. M. Woodward, Members Am. Soc. C.E.; and Thorndike Saville, M. Am. Soc. C.E., Executive Engineer.

Engineering Index Incorporates

ENGINEERING INDEX, Inc., is now making an appeal to the nation's industry operating in technical fields for a working capital fund of approximately $160,000. With this fund it will continue its present service and spread its use throughout the engineering offices, libraries, and colleges of the country. According to Collins P. Bliss, dean of the School of Engineering at New York University and president of the Board of Directors of the Index, such a fund will suffice for a five-year period, after which it is estimated that the service will be self-sustaining. Thus will this fifty-year-old engineering institution enter a new and wider field.

In June of 1934 the Index was formally incorporated as a non-profit-making organization. This followed an extensive study by an outside organization, which developed the conclusions that the Index service is unique in its field and, for scientific purposes, is not duplicated by any other indexing and abstracting service; that if it were not for the Index, the engineering field would be the only major field of scientific knowledge without a complete and effective organization of its current literature; that precedent for a campaign in industry for the Index is found in the raising of money for cooperative industrial research, of which there has been an increasing amount even during the depression; and that the Index is an important if not a vital aid to industrial research and is widely used in that capacity.

The study last spring included a cross section of opinion in the profession, obtained through personal interviews with representative engineers in New York, Philadelphia, Boston, Detroit, and Chicago. The majority opinion was that the Index should by all means be preserved; and further, that the responsibility for saving it, by giving it a capital fund with which to operate, rests upon industry.

To those not already familiar with the Index, it may be described as a virtually complete catalogue, with annotations, of periodical literature in all branches of engineering. The merits claimed for the service include completeness, descriptiveness, promptness, and accuracy. The Index is published in two separate forms. The annual volume is roughly similar to complete indexes in other scientific fields, such as *Index Medicus* in the medical field. More unusual is the card service, which is a cumulative card index of technical periodical literature subdivided into approximately 280 divisions, which may be had in any desired combination. About 2,000 publications, including those of the Society, are reviewed by Index editors. These periodicals come from 40 countries and are in 20 languages. The department, "Current Periodical Literature," which has appeared in each issue of CIVIL ENGINEERING to date, contains three pages of abstracts of civil engineering articles prepared by the Index Service.

The charter of the Engineering Index, Inc., a non-profit-making corporation under the New York State law, provides for 50 trustee members who are to represent all the important engineering bodies in the country. Plans for the campaign call for a National Campaign Committee and local committees for each of 12 industrial centers. National Committee headquarters have been established at 25 West 43d Street, New York, N.Y.

Bridge Design Competition

FOR THE SEVENTH year the American Institute of Steel Construction announces a bridge design competition for students of engineering and architecture. Since the purpose is to encourage improvement in the appearance of steel bridges, the contest is open to students registered in any recognized technical school of the United States. Cash prizes of $100 and $50 are to be given for the designs awarded first and second place, respectively, and suitable certificates will be presented to those who receive honorable mention.

A grade-crossing elimination project is the assignment—a two-lane highway crossing a railroad and another highway parallel to the railroad. The contest is to be divided into two parts, first a preliminary drawing from each contestant, from which will be chosen the designs deemed worthy of development in final form. The preliminary drawings must be received by March 16, 1935, and the final designs by April 27, 1935, at the offices of the American Institute of Steel Construction, 200 Madison Avenue, New York, N.Y. Information regarding details of the contest may be obtained at the same address.

NEWS OF ENGINEERS

From Correspondence and Society Files

B. F. WILLIAMS is now employed as a PWA engineer inspector on port construction work at Brownsville, Tex., for the Brownsville Navigation District. He was formerly State Reclamation Engineer of Texas.

C. W. HAASIS recently received a PWA appointment as assistant state engineer inspector for Tennessee and Kentucky. His headquarters are in Nashville, Tenn.

DONALD O. NELSON has accepted an appointment as structural engineer for Mason-Walsh-Atkinson-Kier, contractors on the Grand Coulee Dam.

NICOLAS E. MANASSEH has been promoted to the position of resident civil engineer in Tripoli (Lebanon) for the Iraq Petroleum Company.

WILLIAM M. SPANN, who was formerly in the Missouri State Engineer's Office, has now been made president of the Tuttle-Ayres-Woodard Company, a firm engaged in general surveying and engineering practice in Kansas City, Mo., and vicinity.

SAM A. NIXON has resigned from the staff of the Agricultural and Mechanical College of Texas to accept a position as civil engineer in the Soil Erosion Service of the U. S. Department of the Interior. His headquarters are at Temple, Tex.

EDWIN H. EATON, formerly assistant engineer with the George H. Flinn Corporation, of Elmhurst, N.Y., has accepted a position in the Real Estate Department of the Bond and Mortage Guarantee Corporation, in Brooklyn, N.Y.

CARLOS QUIRINO SIMÕES has been appointed administrative director in the State Highway Department of the Republic of Brazil. Until recently he held the position of acting director of the same department.

CHARLES V. BROWN, JR., formerly with the U. S. Waterways Experiment Station at Vicksburg, Miss., is now a junior engineer with the Beach Erosion Board, in the office of the Chief of Engineers, U. S. Army, with headquarters in Washington, D.C.

H. S. RIESBOL has been promoted from the grade of junior civil engineer to that of associate agricultural engineer in the U. S. Department of Agriculture. He is in charge of engineering investigations for the Red Plains Soil Erosion Experiment Station in Guthrie, Okla.

A. F. BARCLAY, formerly chief engineer of the New Orleans Public Belt Railroad, has been appointed general manager of this railroad, with offices in New Orleans, La.

M. J. C. ANDREWS is now employed as an assistant to the sanitary engineer of the city of Seattle, engaged in making a survey of the sanitary conditions of that city and of King County.

H. S. JACOBY has severed his connection with the NRA to join the staff of Ohio State University in the capacity of director of industrial research. His headquarters are in Columbus, Ohio.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From December 10, 1934, to January 9, 1935, Inclusive

ADDITIONS TO MEMBERSHIP

ABELSON, HAROLD NORMAN (Jun. '34), Chainman, State Highway Dept., 2204 East 35th St., Tacoma, Wash.

AKKERMAN, WILLIAM HERMAN (Jun. '34), 7316 Satsuma St., Houston, Tex.

ARNOLD, CECIL CUSHMAN (Assoc. M. '34), Bridge Designer, State Dept. of Highways (Res., 317 East 21st Ave.), Olympia, Wash.

ATWELL, KENNETH TILDEN (Jun. '34), 740 East 3d, South, Salt Lake City, Utah.

BAKER, STANLEY LOREN (Jun. '34), Sewerage Supt., City Hall, Newton, Iowa.

BEALL, RALPH RODNEY (Jun. '34), Bealsville, Pa.

BELKNAP, EDWARD MANSFIELD (Jun. '34), Junior Computer, Soils Laboratory, Corps of Engrs., U.S.A. (Res., 961 Brighton Boulevard), Zanesville, Ohio.

BOTTA, ADELMO (Jun. '34), 96 North 6th St., Paterson, N.J.

BRADLEY, CHARLES SMITH (Jun. '34), 2001 Harrison Boulevard, Boise, Idaho.

BRICE, HERMAN DYER (Jun. '34), Field Engr., U. S. Geological Survey, Pleasantville, Iowa.

BROWN, GEORGE FRANK (Assoc. M. '34), 1177 Tremaine Ave., Los Angeles, Calif.

CHAB, VICTOR (Jun. '34), 2012 Eighth St., Columbus, Nebr.

COGEN, SOL (Jun. '34), 100 South Harper Ave., Los Angeles, Calif.

DARLING, JAMES WILLIAM (Jun. '34), 2008 Poplar Ave., Kansas City, Mo.

DAVIDSON, IAN MACLEOD (Jun. '34), 95 Temple Ave., Newnan, Ga.

DIETZ, JOHN RAPHAEL (Jun. '34), 33 Powderly St., Carbondale, Pa.

FALKNER, FRANCIS HOWARD (Jun. '34), Lieut., Corps of Engrs., U.S.A., Asst. Director, U. S. Waterways Experiment Station, Box 665, Vicksburg, Miss.

FEDERMAN, BENJAMIN SAMUEL (Jun. '34), 2985 Botanical Sq., New York, N.Y.

FISCHER, MERLE EDWARD (Jun. '34), With State Highway Dept. (Res., 1355 Forty-fourth St.), Sacramento, Calif.

FISHER, WILLIAM (Jun. '34), 2351 Centre Ave., Pittsburgh, Pa.

FLATAU, FREDERIC MYER (Jun. '34), Civ. Engr., Willmut Gas & Oil Co., Box 1407, Hattiesburg, Miss.

FOLTZ, FRANKLIN J. (Jun. '34), Route 2, Box 102, Phoenix, Ariz.

FREDERICKS, CHARLES WILLIAM (Jun. '34), Draftsman, Met. Water Dist. of Southern California, 715 West 30th St., Los Angeles, Calif.

FUCHS, ROBERT JOHN (Jun. '34), 744 Westminster Rd., Brooklyn, N.Y.

FURLONG, WRAY CLIFFORD (Jun. '34), Care, State Highway Comm., Leon, Iowa.

GLEESON, WILLIAM PAUL (Jun. '34), 1152 Bryant Ave., New York, N.Y.

GOLDBERG, SAMUEL (Jun. '34), 1636 St. Nicholas Ave., New York, N.Y.

GORDON, ISIDOR (Jun. '34), Eng. Asst., Bureau of Eng. Constr. (Res., 241 Henry St.), New York, N.Y.

GRAEF, FREDERICK ERNEST, JR. (Jun. '34), 1524 North 62d St., Philadelphia, Pa.

GRAPES, FRANK EDWARD (Jun. '34), 431 Riverside Drive, New York, N.Y.

GRAY, GARLAND LEE (Jun. '34), With Met. Water Dist. of Southern California, 1418 Paseo del Mar, San Pedro, Calif.

GREENE, ROBERTS WESTERVELT (Jun. '34), 295 Hook Pl., Ithaca, N.Y.

GREENLAW, ARNOLD ZIEGLER (Jun. '34), Care, U. S. Bureau of Reclamation, Earp, Calif.

GREENSPAN, NOAH (Jun. '34), 359 Elton St., Brooklyn, N.Y.

GUTMAN, HENRY (M. '34), Chf. Draftsman, Bridge Dept., D. L. & W. R.R., Hoboken, N.J. (Res., 214 East 20th St., New York, N.Y.).

HARGRAVE, WILLIAM PERCY (Assoc. M. '34), Office Engr., S. P. Co. (Res., 2449 Donner Way), Sacramento, Calif.

HARTON, THOMAS GORDON (Jun. '34), Rodman, Eng. Service Div., Tennessee Val. Authority, Wilson Dam, Ala.

HAVLAK, WILLIAM RICHARD (Jun. '34), 302 Harrison Ave., Avalon, Pa.

HEDIN, WILLIAM NELS (Jun. '34), 2312 Federal Ave., Seattle, Wash.

HILL, CLAIR ASHCRAFT (Jun. '34), Care, Arthur Thomas, 524 Bartlett Ave., Woodland, Calif.

HOLMAN, EDWIN ASA (Jun. '34), 85 Eaton Pl., East Orange, N.J.

HOUSER, HOWARD RAY (Jun. '34), With Frigidaire Div., General Motors Corp., 230 Lonsdale Ave., Dayton, Ohio.

HOWE, ARTHUR KING (Jun. '34), Eng. Apprentice, P. R. R., New York Div., Jersey City, N.J. (Res., 697 Potomac Ave., Buffalo, N.Y.).

HUBACH, KENNETH GEORGE (Jun. '34), 18 Tiffany Pl., Irvington, N.J.

JACOBSON, ABE CLIFFORD (Jun. '34), 2309 Chelsea Terrace, Baltimore, Md.

JEWETT, RICHARD LEE (Jun. '34), Fort Humphreys, Va.

JOHNSON, NORMAN STANLEY (Jun. '34), 424 North Lake Ave., Pasadena, Calif.

JOHNSON, WALTER HAROLD (Assoc. M. '34), Res. Engr., State Div. of Highways, Sacramento (Res., 8 North Primrose St., Alhambra), Calif.

JORDAN, ABRAHAM (Jun. '34), 315 Sanford Ave., Newark, N.J.

KNEZ, COSMO MININ (Assoc. M. '34), 140 Claremont Ave., New York, N.Y.

KRUMM, ERIC TAHLMAN (Jun. '34), 1336 East Main St., Columbus, Ohio.

LARKIN, FRANKLIN JONATHAN (Jun. '34), Care, The Dravo Contr. Co., Red House, W.Va.

LEWIS, JOHN ALBERT (Assoc. M. '34), With Civ. Works Administration and Temporary Emergency Relief Administration of Dutchess County, R.D. 1, Hopewell Junction, N.Y.

LUSE, CHARLES BENTON (Jun. '34), 229 Ferguson Ave., Wood River, Ill.

LUTES, DAVID WALLACE (Jun. '34), Care, Bureau of Reclamation, All-American Canal, Yuma, Ariz.

LYNCH, VINCENT JOSEPH (Jun. '34), 159 Burton Ave., Hasbrouck Heights, N.J.

MCINTOSH, WALTER TOWNSEND (M. '34), Estate Planner, Empire State Bldg., New York, N.Y. (Res., 15 Park St., Tenafly, N.J.)

MCNAIR, ARTHUR JAMES (Jun. '34), 422 West 7th St., Leadville, Colo.

MARTIN, HUGER FRED (Jun. '34), 4841 Tremont, Dallas, Tex.

MELTON, THORNTON CARTER (Assoc. M. '34), Chf. of Party, State Highway Comm., Richmond, Va.

MENO, CARL LEROY (Assoc. M. '34), Asst. Engr., U. S. Bureau of Reclamation, Camp Verde, Ariz.

MERRYFIELD, FRED (Assoc. M. '34), Asst. Prof., Civ. Eng. Oregon State Coll. (Res. 131 North 23d St.), Corvallis, Ore.

MOORE, BYRD LEE (Assoc. M. '34), Chf. Designer, State Highway Dept., Div. 6 (Res., 453 Longfellow), Kirkwood, Mo.

NEIMAN, HERMAN BURBANK (Assoc. M. '34), Field Engr. and Supt., United Engrs. & Constructors, Inc., 1401 Arch St. (Res., 6622 Morris Park Rd.), Philadelphia, Pa.

NEU, FREDERICK WILSON (Jun. '34), Transitman, New Jersey Riparian Survey, Monmouth County Rivers, Box 6, Leonardo, N.J.

NEWTON, NORTH HENKLE (Jun. '34), R.R. 2, Urbana, Ohio.

NUÑEZ Y CANCIO, EMILIO LEOPOLDO (Jun. '34), 3823 Beecher St., N.W., Washington, D.C.

OWENS, JOHN CUSTER (Assoc. M. '34), Box 551, Newark, Ohio.

PICKETT, GEORGE HENRY (Jun. '34), 274 Marguerita Lane, Pasadena, Calif.

PICKRON, FELIX CORLEY (Jun. '34), Box 76, Damascus, Ga.

POLLOCK, SIDNEY (Jun. '34), 245 Rosedale Drive, Pottstown, Pa.

REXWORTHY, EDWARD SIBREE (Jun. '34), 2085 Sacramento St., San Francisco, Calif.

SCHNEIDER, CHARLES GEORGE (Jun. '34), 38 Wickes Ave., Yonkers, N.Y.

SCHREINER, JOHN EDWARD (Jun. '34), 4504 Washington Boulevard, Chicago, Ill.

SCHUEHLE, MARTIN LOUIS (Jun. '34), 9316 Seventh Ave., South, Seattle, Wash.

SIMMONDS, JULES GOTTFRIED (Jun. '34), Asst. to Maintenance Engr., Bing & Bing, 119 West 40th St. (Res., 1560 Amsterdam Ave.), New York, N.Y.

TOTAL MEMBERSHIP AS OF JANUARY 9, 1935	
Members	5,686
Associate Members	6,078
Corporate Members	11,764
Honorary Members	18
Juniors	3,041
Affiliates	98
Fellows	4
Total	14,925

SMALL, ROLAND ROBERT (Jun. '34), 2537 Valentine Ave., New York, N.Y.

SMITH, JEFFERSON LUSK (Jun. '34), 8415 Pritchard Pl., New Orleans, La.

SNELL, JOHN RAYMOND (Jun. '34), Instr., Civ. Eng., Hangchow Christian Coll., Zakow, Che., China.

STEVENS, WILLIAM CONDIT (Jun. '34), 1850 Eighty-fifth St., Brooklyn, N.Y.

STRAUS, HAROLD SELIG (Jun. '34), 2440 Winchester Ave., Ashland, Ky.

TAYLOR, GEORGE EDWARD, JR. (Jun. '34), Field Engr., Annapolis Met. Sewer Comm. (Res., 105 Prince George St.), Annapolis, Md.

THOMPSON, ROBERT WILLIAM, JR. (Jun. '34), 1626 North Dover St., Philadelphia, Pa.

THOMPSON, THOMAS FIELDS (Jun. '34), With Bridge Dept., State Highway Comm., 301 North East 23d St., Oklahoma City, Okla.

TORSKY, NICHOLAS KAPETON (Assoc. M. '32), 420 East 130th St., New York, N.Y.

VERNIER, ROBERT LOUIS (Jun. '34), Junior Engr., Standard Oil Co. of California, San Francisco (Res., 679 Mirada Ave., Stanford University), Calif.

WHITE, JOHN DALE (Jun. '34), Care, Soil Erosion Service, Galva, Ill.

WILLIAMS, ALOYSIUS JOHN (Assoc. M. '34), Eng. Asst., Dept. of Sanitation, 54 Lafayette St., New York (Res., 32-11 Eighty-third St., Jackson Heights), N.Y.

WILLIAMS, BELMONT MURRAY (Jun. '34), 755 Curry Rd., Schenectady, N.Y.

WILLIE, LAVERN J. (Jun. '34), Rodman, State Highway Dept., Ione, Wash.

WINTZ, EDWARD RAMSEY (Jun. '34), Junior Civ. Engr., Met. Water Dist. of Southern California, 3208 Mulberry St., Riverside, Calif.

ZAPP, LLOYD OTTO (Jun. '34), Junior Engr., Humble Oil & Refining Co., Tomball (Res., 600 Byrne St., Houston), Tex.

MEMBERSHIP TRANSFERS

BOOTH, DONALD PRENTICE (Jun. '29; Assoc. M. '34), Lieut., Corps of Engrs., U.S.A., Asst. to Dist. Engr., 255 Federal Bldg., Rock Island, Ill.

CRESSY, FRANK BEECHER (Jun. '27; Assoc. M. '34), Res. Engr. of Constr., State Dept. of Public Works, Div. of Highways, Los Angeles (Res., 247 Santa Ana Ave., Long Beach), Calif.

DUFFY, WILLIAM BERNARD (Jun. '27; Assoc. M. '34), Supt. of Public Works (Res., 72 Greene St.), North Andover, Mass.

ELLIS, MERLE WILSON (Jun. '29; Assoc. M. '34), Asst. Highway Engr., State Highway Comm., Box 702, Bishop, Calif.

HENNES, ROBERT GRAHAM (Jun. '29; Assoc. M. '34), Instr., Civ. Eng., Dept. of Civ. Eng., Univ. of Washington, Seattle, Wash.

KLINE, WILMER ZIEGENFUSS (Assoc. M. '20; M. '34), Associate Civ. Engr., 4th Naval Dist., Navy Dept., Public Works Dept., Navy Yard (Res., 203 West Tabor Rd.), Philadelphia, Pa.

MASON, HENRY MCCRACKEN (Jun. '27; Assoc. M. '34), Concrete Technician, U. S. Engrs., Bonneville Dam, Warrendale, Ore.

SCHIRMER, HOWARD AUGUST (Jun. '24; Assoc. M. '34), Structural Engr., McClintic-Marshall Corporation, San Francisco (Res., 1444 Fourteenth St., Oakland), Calif.

SEELY, HOMER RUSSELL (Jun. '23; Assoc. M. '29; M. '34), Res. Engr., Triborough Bridge Authority, 111 Eighth Ave., New York, N.Y. (Res., 82 Joyce Rd., Tenafly, N.J.)

SHUTTS, ELMER EDWARD (Assoc. M. '27; M. '34), Cons. Civ. Eng. (F. Shutts & Sons), 921½ Ryan St., Lake Charles, La.

STANLEY, ROBERT TALLMADGE (Jun. '26; Assoc. M. '34), Bridge Draftsman, State Highway Comm., 1000 North Capitol St., Salem, Ore.

REINSTATEMENTS

ALTMAN, FRANK STORK, Assoc. M., reinstated Jan. 1, 1935.

BRODINE, ALFRED R., Assoc. M., reinstated Jan. 1, 1935.

FIELD, GEORGE ADDISON, Assoc. M., reinstated Jan. 2, 1935.

FRIENDLY, HUGO HENRY, Assoc. M., reinstated Jan. 7, 1935.

HAMILTON, GEORGE WELLINGTON, M., reinstated Jan. 4, 1935.

HASLEY, THOMAS RICHARD, M., reinstated Jan. 1, 1935.

HILLER, ROBERT J., Assoc. M., reinstated Jan. 1, 1935.

HOTKIEWICZ, WILLIAM JOSEPH, Jun., reinstated Jan. 8, 1935.

MCNAMARA, NEIL STUART, Assoc. M., reinstated Jan. 4, 1935.

RAMEY, ALLEN, Assoc. M., reinstated Jan. 5, 1935.

ROBERTS, JOHN DONALD, Jun., reinstated Jan. 2, 1935.

VOTAW, FRANCE EDGAR, Assoc. M., reinstated Jan. 1, 1935.

RESIGNATIONS

ALLING, KENNETH DAVENPORT, Jun., resigned Dec. 11, 1934.

BARBER, CLIFTON ASEL, Jun., resigned Dec. 31, 1934.

BRENNAN, WILLIAM ANDERSON, Assoc. M., resigned Dec. 10, 1934.

BUCK, ROSWELL SEYMOUR, Jun., resigned Jan. 7, 1935.

BURKE, CHARLES HEISEY, Assoc. M., resigned Dec. 31, 1934.

CHENEY, SHERWOOD ALFRED, M., resigned Dec. 31, 1934.

EVERHARD, PAUL HENRY, Assoc. M., resigned Dec. 31, 1934.

GIFFORD, PORTER WILLIAM, Affiliate, resigned Dec. 19, 1934.

GRANDY, ALEXANDER CHARLES, Assoc. M., resigned Dec. 31, 1934.

GREBE, KARL ANDREW, Jun., resigned Dec. 10, 1934.

HALL, GEORGE ALBRO, Jun., resigned Dec. 19, 1934.

HAVENSTEIN, PERCY WALTER, M., resigned Dec. 11, 1934.

HEUER, ROBERT BURKE, Jun., resigned Jan. 1, 1935.

HOLST, UFFE JUUL, Assoc. M., resigned Dec. 28, 1934.

HORTON, GEORGE LAFLIN, Affiliate, resigned Dec. 26, 1934.

IRWIN, ORLANDO WILLIAM, Assoc. M., resigned Dec. 28, 1934.

JOHNSON, ROY WILLIAM, Jun., resigned Dec. 20, 1934.

KELLEY, EARL FOSTER, M., resigned Dec. 31, 1934.

KILIAN, THEODORE PHILIP, Assoc. M., resigned Dec. 31, 1934.

LAWRENCE, RALPH JORDAN, M., resigned Dec. 31, 1934.

LUSH, WILLIAM HENRY, Assoc. M., resigned Dec. 28, 1934.

LYSE, ALVIN THEODORE, Assoc. M., resigned Dec. 11, 1934.

MCBRIDE, IRWIN CALDWELL, Assoc. M., resigned Dec. 20, 1934.

MCNEELY, JOHN JOSEPH, Assoc. M., resigned Dec. 10, 1934.

MESSINA, RICHARD FRANK, Jun., resigned Dec. 27, 1934.

MICHEL, FREDERICK JOHN, Jun., resigned Dec. 31, 1934.

MORITZ, GORDON DURRIE, Jun., resigned Dec. 20, 1934.

MUELLER, CHESTER, Assoc. M., resigned Dec. 31, 1934.

MULLIN, HOWARD LEON, Jun., resigned Dec. 11, 1934.

PARK, JAMES CALDWELL, Assoc. M., resigned Dec. 31, 1934.

PARKES, GEOFFREY ALEXANDER, Assoc. M., resigned Dec. 13, 1934.

PHELAN, JOHN GERALD, Assoc. M., resigned Dec. 26, 1934.

RONAN, EDWARD SANFORD, JR., Jun., resigned Dec. 28, 1934.

SAILER, WILLIAM PAUL, Jun., resigned Dec. 20, 1934.

SCHANTL, HANS, M., resigned Dec. 19, 1934.

SEABROOK, CHARLES COURTNEY, Jun., resigned Dec. 21, 1934.

SIMPSON, ABEL FARRINGTON, Assoc. M., resigned Dec. 31, 1934.

SIMPSON, AUGUSTUS HOFFMAN, Jun., resigned Dec. 19, 1934.

SLEDGE, LAMAR COBB, Jun., resigned Dec. 26, 1934.

SMITH, MAXWELL WAIDE, M., resigned Dec. 28, 1934.

STEVENS, WILLIAM WENTWORTH, M., resigned Dec. 26, 1934.

TRASK, GEORGE FRANCIS DONNELL, M., resigned Dec. 8, 1934.

VOGHT, WALTER RYAN, Jun., resigned Dec. 31, 1934.

VOSBURGH, JAMES COOPER, Assoc. M., resigned Dec. 31, 1934.

WHITNEY, HERBERT ANGELL, M., resigned Dec. 31, 1934.

WILDER, GLENN SAFFORD, Jun., resigned Dec. 31, 1934.

WILLIAMS, FRED THOMAS, M., resigned Dec. 26, 1934.

WILLIAMSON, HARRY, Assoc. M., resigned Dec. 31, 1934.

WOODS, THOMAS SINCLAIR, Jun., resigned Dec. 26, 1934.

DEATHS

BADER, EDWARD LAWRENCE, JR. Elected Jun. Nov. 14, 1927; died Sept. 20, 1934.

BOND, GEORGE MEADE. Elected M., Feb. 2, 1887; died Jan. 6, 1935.

BREUCHAUD, JULES. Elected Affiliate June 5, 1889; M., Oct. 5, 1898; died Dec. 28, 1934.

BRYAN, GEORGE, JR. Elected M., Jan. 17, 1927; died Nov. 1, 1934.

BURR, WILLIAM HUBERT. Elected Jun., June 3, 1874; Affiliate May 5, 1880; M., March 3, 1886; died Dec. 13, 1934.

CLARK, GEORGE HALLETT. Elected Jun., Oct. 3, 1893; Assoc. M., April 6, 1898; M., Oct. 31, 1905; died Dec. 6, 1934.

ELLIOTT, GEORGE ALEXANDER MILLER. Elected Assoc. M., Sept. 5, 1911; M., June 24, 1914; died Dec. 23, 1934.

ERISMAN, CHARLES WESLEY. Elected Assoc. M., Aug. 28, 1922; died June 15, 1934.

FAUDE, FREDERIC MORRIS. Elected Assoc. M., Dec. 6, 1915; died Nov. 28, 1934.

GARTRELL, FRANK LEWIS. Elected Assoc., M., Jan. 23, 1933; died Nov. 14, 1934.

JOHNSON, OLIVER BERTRAND. Elected Jun., June 4, 1928; died Dec. 21, 1934.

JONES, HENRY LLEWELLYN. Elected Assoc. M., Oct. 5, 1898; died Jan. 6, 1935.

KETCHUM, MILO SMITH. Elected Assoc. M., Sept. 4, 1901; M., March 3, 1908; Hon. M., Oct. 2, 1934; died Dec. 19, 1934.

KING, WALTER JACOB. Elected Assoc. M., Oct 14, 1919; died Nov. 26, 1934.

O'HARA, FRANCIS JOSEPH. Elected M., July 11 1921; died July 23, 1934.

ORR, ALEXANDER. Elected Jun., June 4, 1901 Assoc. M., Feb. 5, 1902; died Jan. 7, 1935.

RICKETTS, PALMER CHAMBERLAINE. Elected Affiliate, Feb. 3, 1886; M., Oct. 5, 1887; Hon. M., Oct. 5, 1931; died Dec. 10, 1934.

ROSENCRANS, EDWIN JOHN. Elected M., May 7, 1902; died Sept. 8, 1934.

RULE, GEORGE BENJAMIN. Elected Assoc. M., June 9, 1930; died Aug. 9, 1934.

STEIN, CHARLES HENRY. Elected M., July 9, 1912; died Jan. 3, 1935.

VAN HOESEN, EDMUND FRENCH. Elected M., July 1, 1891; died May 26, 1934.

WEGMANN, EDWARD. Elected M., Mar. 7, 1888; died Jan. 3, 1935.

WHITE, THOMAS WILLIAM. Elected M., Sept. 10, 1923; died March 17, 1934.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

February 1, 1935 NUMBER 2

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

FOR ADMISSION

BALL, JAMES WESLEY, Ft. Collins, Colo. (Age 29.) Jun. Engr., Hydr. Laboratory, U. S. Bureau of Reclamation, Colorado Agricultural Coll. Refers to E. W. Lane, R. L. Parshall, J. L. Savage, J. E. Warnock.

CLARE, HORACIO EMILIO, Panama City, Panama. (Age 23.) With Grebien & Martinz, Inc. Contrs. Refers to H. G. Arango, R. P. Black, F. C. Snow, R. E. Spaulding.

CONWAY, HENRY THOMAS, Lowell, Mass. (Age 24.) Gen. Supervisor, FERA. Refers to A. Haertlein, L. J. Johnson, H. M. Turner.

CULP, MELVIN MARK, Mounds, Ill. (Age 25.) Supt. of Camp 69-DPE, State of Illinois, Emergency Conservation Work. Refers to H. Cross, W. C. Huntington, C. R. Logan, T. C. Shedd.

DI STASIO, JOSEPH, New York City. (Age 45.) J. Di Stasio & Co., Cons. Engrs. Refers to R. L. Bertin, S. F. Holtzman, G. E. J. Pistor, N. A. Richards, E. E. Seelye, C. B. Spencer, H. V. Spurr, A. W. Stephens, C. H. Sutherland.

EHRLICH, OSCAR CHASKELL, Brooklyn, N.Y. (Age 27.) Eng. Div., Dept. of Sanitation, New York City. Refers to H. R. Codwise, H. P. Hammond, L. F. Rader, E. J. Squire.

GAVARIS, PETER THEODORE, New York City. (Age 21.) Refers to J. E. Perry, C. L. Walker.

GRUNDLER, FRANCIS EDWARD, Bloomington, Ill. (Age 31.) Asst. Engr. with J. J. Woltmann, Cons. Engr. Refers to L. P. Corcoran, J. P. Gebhard, W. R. Reuter, E. D. Roberts, J. J. Woltmann.

HARMAN, ASHER WATERMAN, Richmond, Va. (Age 35.) State Engr. and Director of Work Div., VERA. Refers to J. A. Anderson, F. Jones, J. H. Pratt, J. M. Ribble, A. J. Saville.

HEAVEY, WILLIAM FRANCIS, Cleveland, Ohio. (Age 39.) Major, Corps of Engrs.; Asst. to Div. Engr., Great Lakes Div. U. S. Engrs. Refers to T. B. Larkin, G. R. Lukesh, E. M. Markham, J. J. Phelan, G. B. Pillsbury, L. C. Sabin, M. C. Tyler.

JACOBSON, JAMES HENRY, Chicago, Ill. (Age 47.) Pres., American Concrete Expansion Joint Co. Refers to C. M. Hathaway, C. L. Post, F. T. Sheets, F. Tarrant, C. H. Westcott.

JAQUET, HAROLD HENRY, New Iberia, La. (Age 28.) Gen. Supt., Jefferson Lake Oil Co., Inc. Refers to J. F. Coleman, D. Derickson, W. B. Gregory, S. Seiferth, H. A. Wilson.

KADIE, CARL HENRY, JR., Denver, Colo. (Age 24.) Jun. Engr., U. S. Dept. of Interior, Bureau of Reclamation, Research Div. Refers to H. C. Bird, W. H. Hall, E. W. Lane, H. R. McBirney.

KAHALE, SOUBHI, Kemariye, Damascus, Syria. (Age 23.) Refers to J. S. Crandell, H. Cross, W. C. Huntington, S. B. Morris, E. S. Sheiry.

KYLE, JAMES GIDEON, Cincinnati, Ohio. (Age 39.) Gen. Mgr. and Executive Head of all Depts., Ohio Valley Concrete Pipe Co. Refers to C. A. Betts, A. J. Bottiger, O. J. Miller, T. A. Polansky, J. S. Raffety, J. E. Root, W. H. Wilson.

LANCEFIELD, ROBERT LYNN, Wilmington, N. C. (Age 26.) With U. S. Engr. Office. Refers to J. O. Hunt, H. J. Wild, C. C. Williams, S. M. Woodward, D. L. Yarnell.

MABRY, BENJAMIN BRADLEY, San Antonio, Tex. (Age 23.) Rodman, Texas State Highway Dept. Refers to T. W. Bailey, M. Johnson.

MALEVICH, STEVEN, Pittsburgh, Pa. (Age 24.) Draftsman, Pennsylvania Dept. of Highways. Refers to A. Diefendorf, F. J. Evans, F. M. McCullough, C. B. Stanton, H. A. Thomas.

MARTIN, HAROLD MELVILLE, Denver, Colo. (Age 26.) Jun. Engr., U. S. Bureau of Reclamation. Refers to W. K. Hatt, W. J. Henderson, E. W. Lane, G. E. Lommel, R. B. Wiley.

MONTILLA-COLL, NORBERTO, Arecibo, Puerto Rico. (Age 26.) Engr., Puerto Rico E.R.A. Refers to F. Fortuno-Selles, J. D. Morales, R. Ramirez, R. Skerrett-Landron, E. Totti y Torres.

PEDRI, HENRY GUIDO, Rock Springs, Wyo. (Age 26.) Rodman with H. W. Bashore, Casper, Wyo. Refers to H. W. Bashore, R. D. Goodrich, E. Hudman, H. T. Person.

PEEBLES, ARCHIBALD, Vancouver, B.C., Canada. (Age 30.) Instructor, Dept. of Civ. Eng., Univ. of British Columbia. Refers to E. F. Carter, E. A. Cleveland, A. H. Finlay, E. G. Matheson, H. B. Muckleston.

RANDALL, CAREY ALLEN, Baton Rouge, La. (Age 22.) Teaching Fellow, Coll. of Eng., Louisiana State Univ. Refers to N. E. Lant, B. W. Pegues.

RATTNER, RAYMOND, New York City. (Age 26.) Draftsman, CWA. Refers to A. H. Diamant, L. M. Moisseiff, T. Saville, C. T. Schwarze, F. W. Stiefel, D. S. Trowbridge.

REAM, JOHN MILTON, Akron, Ohio. (Age 34.) Field Engr., The Carmichael Constr. Co. Refers to J. W. Bulger, R. C. Durst, R. L. Harding, W. R. La Due, L. L. Schmucker.

SHARRER, WILFRED HENRY, Syracuse, N.Y. (Age 24.) Refers to E. F. Berry, E. F. Church, L. Mitchell, S. D. Sarason.

SOWER, JAMES EDMUND, Denver, Colo. (Age 29.) Jun. Engr., U. S. Bureau of Reclamation. Refers to J. J. Hammond, J. R. McAuliffe, L. G. Puls, B. W. Steele, B. S. Thayer.

STEWART, DOUGLAS MACMILLAN, Bethlehem, Pa. (Age 22.) Refers to J. B. Babcock, 3d, C. B. Breed, I. M. Lyse, H. G. Payrow, C. M. Spofford, C. H. Sutherland.

THOMAS, CHARLES WALTER, Ft. Collins, Colo. (Age 28.) Laboratory Asst. and Jun. Engr., Hydr. Laboratory, U. S. Bureau of Reclamation, Colorado Agricultural Coll. Refers to E. W. Lane, R. L. Parshall, J. L. Savage, J. E. Warnock.

TOWNSEND, HENRY MCDONALD, Washington, D.C. (Age 23.) Jun. Topographical Engr., U. S. Geological Survey. Refers to R. T. Evans, H. Munroe, C. L. Sadler, J. G. Staack, C. F. Wasser.

VANDEGRIFT, LOUIS EDMOND, Columbus, Ohio. (Age 41.) Field Engr. with City of Columbus, Sewer Dept. Refers to O. Bonney, J. H. Gregory, P. M. Holmes, C. B. Hoover, C. T. Morris, J. R. Shank, C. E. Sherman.

VERHELST, JOSÉ MANUEL, Cartagena, Colombia, S. A. (Age 23.) Refers to W. J. Emmons, W. S. Housel, L. C. Maugh, R. L. Morrison, W. C. Sadler.

WEBSTER, FRANK WATKINS, Knoxville, Tenn. (Age 47.) Prin. Highway Engr., Tennessee Valley Authority. Refers to R. H. Baker, C. N. Bass, N. W. Dougherty, E. Harsch, J. L. Neely, Jr.

WOSTER, HOWARD CECIL, Tacoma, Wash. (Age 29.) Asst. Hydr. Engr. and Office Engr., U. S. Geological Survey. Refers to L. Crosby, W. A. Kunigk, G. L. Parker, M. K. Snyder, B. P. Thomas, E. L. Warner, J. G. Woodburn.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

BABEL, HERMAN, Assoc. M., Pittsburgh, Pa. (Elected Oct. 21, 1924). (Age 39.) Asst. Engr., Erecting Dept., American Bridge Co. Refers to J. L. de Vou, J. E. Elliott, F. W. Henrici, R. Khuen, Jr., F. S. Merrill.

EASLEY, ROBERT PURL, Assoc. M., Antioch, Cal. (Elected Oct. 14, 1930.) (Age 48.) Civ. Engr. and Contr. Refers to A. D. Edmonston, E. Hyatt, R. Matthew, C. W. Schedler, Jr., H. I. Wood.

FOCHT, JOHN ARNOLD, Assoc. M., Austin, Tex. (Elected Jan. 16, 1928.) (Age 40.) Prof. of Highway Eng., Univ. of Texas. Refers to E. C. Bantel, J. H. Brillhart, S. P. Finch, J. T. L. McNew, B. N. Noyes, W. J. Powell, T. U. Taylor.

GELSTON, ARTHUR SANFORD, Assoc. M., Berkeley, Cal. (Elected Nov. 28, 1932.) (Age 47.) Res. Engr., California Joint Highway Dist. No. 13. Refers to R. R. Arnold, M. C. Collins, C. Derleth, Jr., H. Goodridge, K. W. Robarts, E. J. Shaw.

HOGAN, JOSEPH VINCENT, Assoc. M., Baltimore, Md. (Elected Oct. 29, 1912.) (Age 49.) Pres., The Arundel Corporation. Refers to J. P. Carlin, A. S. Crane, J. Forgie, F. R. Harris, R. Lacy, T. J. Morrison.

JOHNSON, FRANK MELVIN S, Assoc. M., Golden, Colo. (Elected Junior Jan. 31, 1911; Assoc. M. Jan. 14, 1918.) (Age 45.) Major, Corps of Engrs., U. S. Army; Prof. of Mil. Eng. and Head of Mil. Dept., Colorado School of Mines. Refers to J. C. Fitterer, A. H. Fuller, C. L. Hall, T. H. Jackson, C. C. More, J. J. Morrow, F. T. Oakley, R. A. Thompson.

SHUPTRINE, HARRY AUGUSTUS, Assoc. M., Detroit, Mich. (Elected Oct. 10, 1921.) (Age 47.) Bridge Engr., Board of Wayne County Road Commrs. Refers to G. C. Dillman, G. H. Fenkell, L. M. Gram, J. D. K. Lyman, H. E. Riggs, F. P. Shearwood, C. S. Sheldon, L. C. Smith.

WEEBER, EARL RICHARD, Assoc. M., Grand Rapids, Mich. (Elected Dec. 14, 1925.) (Age 36.) Hamilton & Weeber, Cons. Engrs. Refers to O. Bonney, J. S. Bowman, W. G. Fargo, W. C. Giffels, L. W. Goddard, R. H. Merrill, J. R. Rumsey.

WILSON, MURRAY ALDERSON, Assoc. M., Salina Kans. (Elected March 5, 1928.) (Age 40.) Owner, The Wilson Eng. Co. Refers to E. Boyce, L. E. Conrad, O. J. Eidmann, F. W. Epps, G. S. Knapp, R. J. Paulette, C. H. Scholer.

FROM THE GRADE OF JUNIOR

BARBER, RICHARD, Jun., Seattle, Wash. (Elected Nov. 10, 1930.) (Age 32.) Res. Engr., State Dept. of Highways. Refers to C. E. Cleaver, O. R. Elwell, T. D. MacNeil, T. G. McCrory, R. M. Murray, F. W. Panhorst, M. S. Woodin.

BROWNFIELD, ALLEN HARRY, Jun., San Francisco, Cal. (Elected Jan. 25, 1932.) (Age 30.) Asst. Bridge Constr. Engr., State of California. Refers to R. L. Allin, O. R. Bosso, C. Derleth, Jr. F. S. Foote, S. T. Harding, F. W. Panhorst, D. R. Warren.

DEWESTFELT, GERARD PHILIP, Jun., New York City. (Elected Jan. 26, 1931.) (Age 32.) Elect. Draftsman, Dept. of Development and Research, New York Stock Exchange. Refers to H. K. Barrows, A. T. Beauregard, C. J. Gooch, J. H. C. Gregg, H. A. Sargent.

DORNBLATT, BERNHARD, Jun., Atlanta, Ga. (Elected April 7, 1930.) (Age 32.) Designer. Bridge Dept., State Highway Board of Georgia, Refers to J. W. Barnett, M. E. Cox, B. L. Crenshaw, C. A. Marmelstein, E. N. Seymour, S. B. Slack, F. C. Snow.

GOTTLIEB, ALEX PHILIP, Jun., Bayonne, N.J. (Elected Nov. 15, 1926.) (Age 32.) In charge of Structural Steel Estimating Dept., Hinkle Steel Constr. Co., New York City. Refers to A. J. Bernstein, H. R. Codwise, F. E. Foss, G. Morrison, J. C. Riedel, S. Weishoff, J. P. J. Williams.

GREEN, CARL EDWIN, Jun., Portland, Ore. (Elected Dec. 3, 1928.) (Age 28.) State San. Engr., Oregon State Board of Health. Refers to R. H. Corey, J. W. Cunningham, J. C. L. Fish, R. E. Koon, B. S. Morrow, L. B. Reynolds, E. C. Willard.

INGS, JASPER HAROLD, Jun., Charlottetown, P.E.I., Canada. (Age 32.) Foreman, Dept. of National Defence, airport construction. Refers to O. B. Bestor, A. C. D. Blanchard, F. H. Cothran, C. H. Mitchell, C. R. Young.

LITTLEFIELD, WILLIAM MORRIS, Jun., Rolla, Mo. (Elected April 7, 1930.) (Age 27.) Jun. Engr., U. S. Geological Survey, Missouri Dist. Refers to H. C. Beckman, G. S. Knapp, C. E. McCashin, C. G. Paulsen, J. B. Spiegel.

MOORMAN, ROBERT BURRUS BUCKNER, Jun., Oxford, Miss. (Elected Oct. 14, 1929.) (Age 30.) Asst. Prof. of Civ. Eng., Univ. of Mississippi, University, Miss. Refers to J. J. Doland, M. L. Enger, A. B. Hargis, F. E. Richart, T. C. Shedd.

PERREY, JOSEPH IRVING, Jun., Chattanooga, Tenn. (Elected Nov. 14, 1927.) (Age 30.) Associate Engr., U. S. Geological Survey. Refers to E. F. Coddington, L. Lee, R. R. Litehiser, C. E. McCashin, C. E. Sherman.

ROETMAN, EDMOND TERRINK, Jun., Elkins, W. Va. (Elected Oct. 10, 1927.) (Age 30.) Engr., Div. of Subsistence Homesteads, Dept. of the Interior, Tygart Valley Homesteads. Refers to G. P. Boomsliter, L. V. Carpenter, R. P. Davis, W. S. Downs, A. H. Fuller, L. J. Murphy.

SAENG-XUTO, SRA MONGKALA, Jun., Bangkok, Siam. (Elected Oct. 21, 1924.) (Age 32.) Chf. Maintenance Engr., Div. of Ways, Dept. of Public and Municipal Works, Govt. of Siam. Refers to T. M. Bhiromya, H. F. Scholtz, P. Sukham. (Applies in accordance with Sec. 1, Art. I, of the By-Laws.)

SMUTZ, HUBER EARL, Jun., Los Angeles, Cal. (Elected Dec. 22, 1930.) (Age 32.) Zoning Engr., Dept. of City Planning. Refers to D. M. Baker, M. Butler, T. Coombs, A. Jones, C. C. Miller, C. J. Shults, D. M. True.

STEWART, ALEXANDER CAMERON, Jun., Waltham, Mass. (Elected April 20, 1925.) (Age 32.) Associate Structural Engr., Procurement Div., Public Works Branch, Treasury Dept., Washington, D.C. Refers to W. S. Anderson, J. W. Dunham, J. H. Eaton, R. G. Focht, F. C. Hilder, A. W. Santelmann.

WORKMAN, LEWIS JACOB, Jun., Denver, Colo. (Elected Feb. 27, 1933.) (Age 32.) Jun. Engr., U. S. Bureau of Reclamation. Refers to J. J. Hammond, A. B. Reeves, J. L. Savage, R. A. See, B. W. Steele.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 85 of the 1934 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when the reply should be sent to the office designated.

CONSTRUCTION

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate; 33; married. Registered in Illinois; 10 years experience in design and construction of factory buildings, ore docks, mining buildings, and hydraulic work for gold mining company, including 4 years on railroad and highway bridges, fixed and bascule. Available immediately. D-3311.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; graduate of Massachusetts Institute of Technology; single; 30; 1 year experience, general contractor and real estate surveyor, New Mexico; 2 years oil field construction and estimating, Venezuela; 2 years in water supply design and in superintending construction, New York; 1 year road construction; 8 months topographic plane table surveying, Persia. Location immaterial. C-4387.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 31; married; Cornell University, A.B. and C.E. degrees; 10 years engineering and construction experience, including railroad and highway location, grade crossings, concrete and steel bridges, retaining walls, cofferdams and caisson work, river development, large-scale excavation jobs, topographic surveys, cost accounting. Excellent references. D-2252.

DESIGN

STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; graduate civil engineer; 10 years experience in structural design of schools and public buildings; at present unemployed; married. New York or New Jersey preferred, but would consider other locations. Moderate salary. C-2080.

SANITARY ENGINEER; Assoc. M. Am. Soc. C.E.; graduate C.E.; 12 years experience in design and construction of sewers and sewage-treatment plants; at present in charge of a million-dollar sewerage project, financed with PWA funds; will be available on short notice. C-874.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; state license; B.S. in C.E. and C.E. degrees; 30; 1 year on bridge construction; 5 years in bridge and building design in charge of important work; now in fourth year teaching as assistant professor of civil engineering. Desires responsible teaching or commercial position with established firm. Available one month's notice. D-3557.

STRUCTURAL DESIGNER; Assoc. M. Am. Soc. C.E.; experienced on bridges, buildings, viaducts, caissons, foundations, bins, etc.; desires position. Available immediately. Will go anywhere. Age 31; 10 years experience. C-8644.

EXECUTIVE

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 30; married; graduate of Massachusetts Institute of Technology, 1929; 3 years experience with salinity survey, computing flow, reservoir operations, deficiencies, durations, tidal data, and determining causes and effects of salinity movements, work requiring much originality; 3 years quantity estimating and detailing structural steel. D-3591.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 30; single; C.E. degree, Pennsylvania State College; 10 years field and office experience, including investigations, reports, surveys, estimates, design, specifications, inspection, supervision on railroad, highway tunnel, mines, municipal, industrial plant, and harbor construction projects. Now specializing in engineering economics. Available immediately; location immaterial. D-2776.

CIVIL AND MECHANICAL ENGINEER; M. Am. Soc. C.E.; member A.S.M.E.; 44; married; graduate mechanical engineer; 24 years field and office, harbor, channel, jetty, bulkhead, and dock construction. Operation, design, and construction of all-sized dredges and marine contracting equipment. Investigations and cost estimates. Available on short notice. D-578.